REPORT RESUMES

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PERSISTENCE AND ATTRITION OF ENGINEERING STUDENTS, A STUDY OF FRESHMAN AND SOPHOMORE ENGINEERING STUDENTS AT THREE MIDWESTERN UNIVERSITIES.

BY- AUGUSTINE, ROGER D.

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BECAUSE OF DECREASING ENGINEERING ENROLLMENTS AND INCREASING ATTRITION RATES, FACTORS RELATED TO PERSISTENCE OR CHANGE IN MAJOR FIELD BY ACADEMICALLY PROFICIENT STUDENTS WERE STUDIED. THE SAMPLE, COMPOSED OF MALE STUDENTS ENTERING AS FRESHMEN AT THREE MIDWESTERN UNIVERSITIES, WAS SUBSEQUENTLY IDENTIFIED AS PERSISTERS OR NON-PERSISTERS. NON-PERSISTERS WERE DEFINED AS STUDENTS WITH AT LEAST A "C" AVERAGE WHO HAD CHANGED TO A NON-ENGINEERING MAJOR DURING THEIR FRESHMAN OR SOPHOMORE YEARS. PERSISTERS AND NON-PERSISTERS WERE MATCHED ACCORDING TO ACADEMIC POTENTIAL. A QUESTIONNAIRE WAS ADMINISTERED AND AN INTERVIEW CONDUCTED TO ASSESS THE NATURE AND IMPORTANCE OF PRE-COLLEGE AND COLLEGE EXPERIENCES INFLUENCING EDUCATIONAL AND VOCATIONAL PLANNING. STATISTICALLY, SIGNIFICANT DIFFERENCES WERE FOUND BETWEEN PERSISTERS AND NON-PERSISTERS. NON-PERSISTERS MORE FREQUENTLY CAME FROM LOWER MIDDLE CLASS HOMES AND WERE GRADUATED FROM CENTRAL CITY OR NON-METROPOLITAN HIGH SCHOOLS. THEY ALSO ATTACHED MORE IMPORTANCE TO SOCIAL STATUS, PRESTIGE, AND THE OPPORTUNITY TO WORK WITH PEOPLE RATHER THAN THINGS. THE AGE AT WHICH SUBJECTS FIRST CONSIDERED A CAREER IN SCIENCE OR ENGINEERING WAS FOUND INVERSELY RELATED TO PERSISTENCE IN AN ENGINEERING PROGRAM. WIDESPREAD DISSATISFACTION EXISTS AMONG PERSISTERS AND NON-PERSISTERS ABOUT THE HIGHLY STRUCTURED AND INFLEXIBLE ENGINEERING CURRICULA. RECOMMENDATIONS ARE MADE BASED UPON THE FINDINGS. (SK)

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PERSISTENCE AND ATTRITION OF ENGINEERING STUDENTS

A Study of Freshman and Sophomore Engineering Students at Three Midwestern Universities

Roger D. Augustine
Assistant to the Dean
College of Engineering
Michigan State University
East Lansing, Michigan

August 1966

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PREFACE

The research reported in this volume was conceived in the belief that the problem of engineering attrition merited further intensive and orderly investigation. This study, conducted at Michigan State University, Northwestern University and The University of Wisconsin, is an attempt to understand better some of the factors which may account for the loss of talented engineering students to other college curricula.

A word is in order concerning the organization of this report. The synopsis briefly summarizes the study and outlines the principal findings. Chapter I provides a discussion of the background of the problem, defines the purpose and goals of the project, suggests the theoretical principles which have undergirded its development, and describes the scope and limitations of the study. The design of the study and its methodology are discussed in Chapter II. The findings based on the questionnaire data and the interview data are reported in Chapter III. Chapter IV presents the conclusions and recommendations for action by engineering societies, engineering schools and high schools.

A thorough review of related literature, a detailed discussion of the construction of the two instruments, and the statistical analysis of the questionnaire data may be found in the project director's doctoral dissertation entitled "Persistence and Change in Major Field of Academically Proficient Engineering Students at Three Midwestern Universities." For the sake of brevity, these topics have been given only minimum attention in this report in order to emphasize the most noteworthy outcomes of the study.

The author is deeply indebted to many people. Unfortunately, it is not possible to recognize here all of those whose interest and cooperation have made this study possible. It is fitting, however, that recognition be given those who have made special contributions.

Dr. Walter F. Johnson, Dr. James W. Costar, Dr. William A. Faunce and Dr. John X. Jamrich--members of the author's doctoral Guidance Committee--have provided constant encouragement and invaluable counsel throughout the course of this investigation. Their assistance is sincerely appreciated.

The author acknowledges the financial support and encouragement of the Alfred P. Sloan Foundation. Dr. J. D. Ryder, Dr. Harold B. Gotaas, and Dr. Kurt F. Wendt--Deans of Engineering at Michigan State University, Northwestern University and The University of Wisconsin, respectively--played important roles in the development of this research at their respective institutions. Their support is gratefully acknowledged. Special appreciation is due Dean J. D. Ryder for his wholehearted encouragement and cooperation in facilitating the work of this project.

Dr. Lois B. Greenfield and Dr. L. Joseph Lins, both of The University of Wisconsin, and Dr. William T. Brazelton of Northwestern University all have made substantial contributions to the investigation. Their willing and effective efforts have enhanced and enriched the study from its conception. The author is also deeply appreciative of the keen interest and personal encouragement of his friends and professional colleagues at Michigan State University: George M. VanDusen, Craig D. Laubenthal and Donald Waterstreet. A special note of gratitude is due Dr. C. R. St. Clair, Jr., who has been most supportive of the author's work.

The writer wishes to express his sincere appreciation to his loyal secretary, Gretchen L. Forsyth, who has made many substantive contributions to the project in addition to effectively managing the various phases of the work. Her gracious personality and competent handling of her responsibilities contributed markedly to the success of the study. The efforts of the many other project assistants during the past year are also gratefully acknowledged.

The research would have been impossible without the cooperation of the students who participated at the three universities. The author owes a continuing debt of gratitude to all of these fine young men. Finally, the author expresses his heartfelt appreciation for the faithful support of his loving wife, Clara Louise.

Although many individuals have contributed to the evolution of this study, the project director assumes sole responsibility for the direction it has taken and the conclusions and recommendations presented in this final report.

Roger D. Augustine

East Lansing, Michigan
August 1, 1966

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SYNOPSIS

Decreasing engineering enrollments and increasing attrition of talented engineering students have attracted the concern of government and industrial leaders, engineering educators and others interested in the Nation's scientific manpower needs. An extensive review of the literature revealed little research which has contributed insight to the causes of these increasing attrition rates. As a result, this exploratory study was designed to identify factors causally related to persistence and change in major field of academically proficient engineering students during their freshman and sophomore years at three midwestern universities.

The population consisted of all the male students who entered engineering at the three universities as first-time freshmen in September 1963. The sample was comprised of two groups--the persisters and non-persisters. The non-persisters were those members of the population who had changed majors to non-engineering curricula during the freshman or sophomore year while earning at least a "C" cumulative grade point average. A comparison group of persisters was established by individually matching students from the population who had demonstrated the same academic potential as the non-persisters but who had persevered in the pursuit of their engineering degrees. A questionnaire and an interview guide were developed to assess the

nature and importance of each student's pre-college and college experiences that influenced his educational and vocational planning.

Of the 326 students invited to participate, 221 (126 non-persisters and 95 persisters) or 68 percent returned questionnaires. Appropriate statistical analyses of the data elicited by the questionnaire revealed the following noteworthy significant relationships.

Non-persisters, proportionately more frequently than persisters, came from lower middle class homes and were graduated from central city or non-metropolitan high schools. Also, they attached more importance to social status and prestige and the opportunity to work with people rather than things. Further, it was found that the age at which respondents first considered the possibility of a career in science or engineering was inversely related to persistence in an engineering program.

Interviews were conducted with a total of 176 students--104 persisters and 72 non-persisters. The findings from these data are based on a content analysis of case notes prepared from the electronic tape recordings of the interviews. The following are the most noteworthy of the interview findings.

1. Although students choose engineering majors for a wide variety of reasons, the following are among the most common for the respondents in this study:

a) success and interest in high school science and mathematics courses,

b) the encouragement toward engineering received from fathers, brothers, relatives and friends,

c) the interest developed while pursuing mechanical or scientific hobbies and leisure-time activities,

d) extrinsic features such as the monetary benefits, prestige and glamour of the field, and

e) the belief that an undergraduate engineering program would provide a sound background for a career in some other field.

2. High school students, teachers, guidance counselors and parents evidently know little about the work of the professional engineer or the nature of the educational programs leading to such careers.

3. Persisters and non-persisters are frequently dissatisfied with the highly structured, inflexible engineering curricula.

4. Certain required courses, especially mathematics, antagonize many students and reinforce misconceptions of the nature of engineering work.

5. Sophomore engineering courses are welcomed and enjoyed by most students.

6. Friends and acquaintances of respondents play important roles in their decisions to continue their engineering studies or change to other curricula.

7. Large proportions of both persisters and non-persisters report passive, procedural relationships with their academic advisers as being typical throughout their college years.

8. Non-persisters cite a variety of reasons for changing out of

engineering. Those most frequently mentioned include:

a) Students had mistaken impressions of the engineering field.

b) Students were dissatisfied with the content of the required courses.

c) The student's scholastic performance did not meet his self-expectations.

d) Students adopted new career goals.

e) Students felt they could find more appropriate routes to the non-engineering career goals they had originally established.

f) Students wanted to explore other career opportunities.

Recommendations were offered for action by engineering societies, engineering schools and high schools. Implications were drawn for further research.

CHAPTER I

THE PROBLEM

Statement of the Problem

Undergraduate engineering enrollments throughout the United States dropped precipitously from 1957 through 1962. These decreases represented even sharper declines in the proportions of engineering students within America's colleges and universities. (10:183) At the same time, reports by both the National Science Foundation (NSF) and the Engineering Manpower Commission indicated a need for an increasing number of engineering graduates to meet the Nation's demand in the decade ahead. This demand was placed at between 48,000 and 72,000 first engineering degrees annually. (9,17) However, total bachelor's degrees conferred between 1957 and 1962 averaged only about 32,000--far fewer than the projected demand. (10:184)

Many industrial executives, government officials, engineering educators and others concerned with the country's manpower supply voiced grave concern over this projected cumulative deficit. As a result of this anxiety, a series of engineering manpower studies appeared during the next few years prepared for private industry, engineering societies, and government committees and agencies. In an excellent analysis of these reports, Dr. Harold A. Foecke summarized their respective contributions and assessed the engineering manpower situation as it appeared in early 1965. Although some dissent was evident, these studies revealed a remarkable unanimity of opinion that the demand for qualified engineers would far outstrip the supply well into the 1970's. (13:3-8) Indeed, Dr. Foecke concluded from an examination of these and other occupational data that "they indicate steady long-term trends toward an increase in the percentage of our population or work force engaged in engineering and other technical pursuits." (13:8)

The mounting concern prompted engineering educators to study enrollment patterns more carefully than ever before. In 1957 freshman engineering enrollments constituted 10.8 percent of the Nation's total freshman enrollments. By 1961, however, this proportion had dropped to 6.6 percent. (19:4) A parallel concern developed about that same time due to increasing rates of attrition from undergraduate engineering curricula. While scant factual data apparently was available to quantify the extent of this problem, the plethora of opinions on the matter left little doubt that this too was a thorn in the side of engineering education. Thus, two primary problems--decreasing enrollments and increasing attrition--had been identified as compounding the shortage of engineers resulting from the natural economic and technological growth of the American society.

A variety of studies were launched to better understand the nature and causes of these enrollment and attrition problems. An investigation by an American Society for Engineering Education (ASEE) committee in 1959 concluded that there was some foundation for the widespread belief that many qualified students were transferring out of engineering programs. (6) In an article on the increasing shortage of engineers and scientists, Heather David succinctly placed the dimensions of the problem in clear perspective: ". . . about half of each (engineering) class does not make it--they flunk out, drop out, and an increasing number switch out." (7:12) The potential consequences of these trends were suggested in the final report of an extensive NSF study conducted in 1961. It concluded that if the proportion of engineering freshmen did not increase, retention rates improve, and transfers into engineering schools rise, the deficit would have to be made up of untrained personnel. (17:33)

What could be done to come to grips with these problems? This question was posed by many including Dr. Robert H. Roy, Chairman of the ASEE Engineering College Administrative Council. In appointing a Committee for the Analysis of Engineering Enrollment in 1961, he observed that "engineering enrollments over the country are down, . . . despite a coincidental rise in the college population. There has been much speculation as to why . . . but, as far as I know, nobody really knows what has brought the down trend about." (1:1) With the aid of a NSF grant a study group was established at the University of Alabama and an investigation initiated during the 1963-64 academic year.

Also in 1963 the Engineering Manpower Commission conducted a survey to ascertain the views of deans of engineering colleges with respect to the attrition of engineering students. The report indicated that there seemed "to be a large area of agreement that:

1. Large numbers of students who are well qualified for engineering are dropping out.
2. High attrition rates cause student disillusionment which reacts against engineering and is one of the principal causes of the declining freshman enrollments. In other words, 'Why take engineering if the odds are stacked against you?'
3. There are effective ways of reducing student attrition if we would face up to the problem." (12:3)

The work of the ASEE study group at the University of Alabama, mentioned above, seemed to further substantiate the belief that over the past several years there has been a trend toward an ever-increasing loss of high-quality engineering students to other fields. It reported that the retention rates in engineering schools appear to have decreased considerably since 1950. At the same time, the study suggested that the percentage of entering engineering freshmen who change majors and graduate in other divisions has steadily increased. (1:33) Significantly, the report's first recommendation urges "that a major effort be made to ensure that a larger fraction of the students who enter engineering successfully complete the degree requirements." (1:5)

Need and Importance of the Study

The extensive literature on enrollments and attrition in the engineering and science fields confines itself primarily to projections and analyses of the supply and demand for technically trained personnel in the years ahead. As a consequence, a better understanding of manpower needs has resulted. However, these efforts have contributed little insight as to what might account for these declining enrollments and increasing attrition rates.

Despite the sharp increases in the number of engineering freshmen since 1963, engineering freshman enrollments continued to decline proportionately relative to the changes in male, first-time enrollments in four-year institutions of higher learning. In fact, undergraduate engineering enrollments in 1965 dropped to 9.5 percent of the country's total male degree-credit enrollment--the lowest point in eight consecutive years and down from 14.6 percent in 1957. (10:184) This trend flies in the face of Foecke's previously quoted conclusion that an increasing proportion of the Nation's work force will necessarily be engaged in engineering and other technical pursuits.

Given this enrollment picture, efforts to identify causes of engineering attrition take on an even greater urgency. It was believed that a project of this nature should raise broad questions dealing with the vocational development of high school and college age youth, particularly as they relate to decisions to study in the natural sciences or engineering. Researchers reviewing a large body of this literature came to a similar conclusion:

> We need a better understanding of the critical decision points during which a student decides to become an engineer. Closely associated with this is the need for attaining a better understanding of the role of parents, teachers, and guidance counselors in shaping career selections. (19:1)

In consideration of these needs, an exploratory study was under-taken to investigate certain dimensions of the problem of engineering attrition. The total group which leaves engineering is comprised of three elements: the dropouts, who discontinue their academic endeavors altogether; the students with deficient scholastic records who transfer to other institutions or other curricula; and those students who are performing satisfactorily in engineering but who change to other fields of study. The latter group of students has received the least attention. Consequently, they will serve as the focus for this study.

Purpose of the Study

As suggested above, it is the purpose of this study to identify factors causally related to persistence and change in major field of academically proficient engineering students during their freshman and sophomore years at three selected universities. An exploratory approach seemed most appropriate in light of the dearth of information available on the causes of engineering attrition. A questionnaire and interview guide were designed and used with a group of students who had left engineering prior to their junior year. To place this information in perspective, similar data were collected from a comparison group of students who had continued to persist in the engineering programs of their respective institutions. Three universities were included in the study to broaden the representativeness of the findings and conclusions. Four goals consistent with the purpose of the study were established to guide the research:

1. To understand better the vocational development process as it is manifested by those students who choose engineering as their college major.

2. To identify factors which help explain and differentiate student decisions to persist in engineering or to change major fields of study.

3. To formulate hypotheses, whenever possible, to serve as a basis for the work of future investigators.

4. To make recommendations based on the outcomes of the study which might prove useful to guidance personnel, engineering educators, professional engineers and others interested in the engineering manpower situation.

Theory

Psychologists, sociologists, educators, economists and others, working separately and together, have contributed much to the understanding of the career decision-making process. From their work has evolved a variety of theories designed to explain the vocational behavior of people in American society. In truth, however, they are all in the elementary stages of theory building, leaving substantial strides to be made in the future. Also, the observer sometimes notes that there is much overlapping from one point of view to another. Often differences are more a matter of emphasis than of substance.

Nevertheless, some theoretical guidelines are necessary if the researcher is not to wander aimlessly about, poking first here and then there for answers to the questions he has raised. The project director has found the thinking of Donald E. Super to be the most helpful in understanding the vocational development process. Super provides an extensive discussion of his views in a book entitled The Psychology of Careers. (23) In another publication in collaboration with several associates, Super offers eleven propositions which have served as working principles in guiding the development of the present project.

The propositions describe the general nature of the vocational developmental process, suggest the effects of role-taking upon the development of the self-concept and relate the effects of both these factors to vocational development. Other propositions deal with the dynamics of career patterns and the concept of occupational multipotentiality of the individual. These eleven propositions (24:89-96) are listed below for the use and convenience of the reader.

Proposition 1. Vocational development is an ongoing, continuous, and generally irreversible process.

Proposition 2. Vocational development is an orderly, patterned process and thus predictable.

Proposition 3. Vocational development is a dynamic process of compromise or synthesis.

Proposition 4. Self-concepts begin to form prior to adolescence, become clearer in adolescence, and are translated into occupational terms in adolescence.

Proposition 5. Reality factors (the reality of personal character-

istics and the reality of society) play an increasingly important part in occupational choice with increasing age, from early adolescence to adulthood.

Proposition 6. Identification with a parent or parent substitute is related to the development of adequate roles, their consistent and harmonious interrelationship, and their interpretation in terms of vocational plans and eventualities.

Proposition 7. The direction and rate of the vertical movement of an individual from one occupational level to another is related to his intelligence, parental socioeconomic level, status needs, values, interest, skill in interpersonal relationships, and the supply and demand conditions in the economy.

Proposition 8. The occupational field which the individual enters is related to his interests and values, the identifications he makes with parental or substitute role models, the community resources he uses, the level and quality of his educational background, and the occupational structure, trends, and attitudes of his community.

Proposition 9. Although each occupation requires a characteristic pattern of abilities, interests, and personality traits, the tolerances are wide enough to allow both some variety of individuals in each occupation and some diversity of occupations for each individual.

Proposition 10. Work satisfactions depend upon the extent to which the individual can find adequate outlets in his job for his abilities, interests, values, and personality traits.

Proposition 11. The degree of satisfaction the individual

attains from his work is related to the degree to which he has been able to implement his self-concept in his work.

Plan of the Study

The three institutions included in the study were Michigan State University, Northwestern University and the Madison campus of The University of Wisconsin. All the male students who entered engineering at these three schools as first-time freshmen in September 1963 constituted the study population. The sample consisted of two groups--the persisters and non-persisters. The persisters were those students who had been enrolled continuously in engineering curricula through the beginning of their junior year. The non-persisters were those students who had changed majors during their freshman or sophomore year to non-engineering curricula while earning at least a "C" cumulative grade point average.

The exploratory nature of the study suggested that the primary data gathering technique be a private, in-depth interview between the project director and each subject. A semi-standardized interview guide was developed to facilitate this phase of the project. Prior to the interview, each subject received a questionnaire and a cover letter from his respective engineering dean explaining the study and inviting the student's participation. The content of both the questionnaire and the interview guide reflected the goals established for the study and the theoretical considerations outlined earlier. Briefly, these instruments were intended to aid the researcher in assessing the nature and impact of each subject's pre-college and college experiences on his educational and vocational decision-making.

Analyses appropriate to the questionnaire and interview data were employed to gain an appreciation of the initial findings. These results were then synthesized and interpreted within the context of the original objectives of the study. The plan for disseminating these findings and recommendations included the distribution of a summary report to deans of engineering schools in the United States, directors of counseling services at those institutions, officers of the prinicpal guidance associations and engineering societies and others concerned with the Nation's engineering and scientific manpower needs.

Limitations of the Study

All research requires a variety of theoretical and operational assumptions in order that the investigator may design a study and draw useful conclusions from the data collected. Limitations are imposed on these findings to the extent that these original assumptions were valid. In addition, as he defines and delimits his project, he further limits the scope of the conclusions which are permissible.

This study is as liable as any with respect to the vagaries which might invalidate the assumptions necessary to move forward with the investigation. Exploratory studies are particularly vulnerable as the design and instrumentation have been developed from a limited body of knowledge concerning the relevant variables under study.

Extreme caution must be exercised during analysis to discern causal relationships from simply symptomatic ones. Statistically significant correlations may not identify meaningful relationships.

The design and methodology of this study impose specific limitations which must be considered in order to clarify the expectations which may properly emerge from the project. Only three engineering schools and one entering engineering class were studied. The latter decision severely restricts the scope of the conclusions which may be drawn. However, this approach seemed defensible in an exploratory study when the limited availability of time, budget and professional staff were taken into account.

The ex post facto design constitutes another major weakness of the study. In his excellent discussion of ex post facto research, Kerlinger cites three primary limitations which must be taken into account in all such studies: "(1) the inability to manipulate independent variables, (2) the lack of power to randomize, and (3) the risk of improper interpretation." (15:371) In addition to these considerations, the present investigation introduces other limitations of some importance. Subjects find it difficult to recall events, feelings and motivations of from four to six years ago. Significant omissions may occur. Subsequent events may have overshadowed or cast a different meaning upon past experiences. All of these problems have obvious implications for the interpretations to be made later in the report.

Finally, a word must be said concerning the use of a questionnaire and an interview guide. Such instruments rely heavily upon the investigator's ability to engender a cooperative attitude on the part of each subject and to elicit full, accurate responses to the questions posed. Also, a serious effort is required to ensure the highest possible reliability and validity of the instruments employed. In this instance, a pretest of both the questionnaire and interview guide suggested that these requirements had been fulfilled. Concerning the interview data itself, it is recognized that attempts to analyze this type of subjective material can meet with only modest success. To increase the reliability of this process, the interviewer prepared case notes from electronic tape recordings prior to the application of a content analysis system related specifically to the information sought in the interviews.

Definition of Terms

Attrition shall be defined for the purpose of this study as all losses from a particular academic program for whatever reason.

Dropouts are those students who discontinue their college studies altogether due to academic, health, military or other reasons.

Transfers are those students who leave one institution for the purpose of continuing their educations at other colleges or universities in the same or different majors.

A major change is the process of switching from one curriculum to another within the same institution.

Persisters are those subjects in this study who were enrolled continuously in engineering curricula through the beginning of their junior year.

Non-persisters are those subjects in this study who had changed majors to non-engineering curricula during their freshman or sophomore year.

An occupation is a category in the social structuring of work. Work activity as seen from the sociological or economic point of view. (24:131)

Vocation refers to the person-centered aspects of work; the psychological conception of work as the behavior of individual persons. (24:131)

Vocational behavior is any interaction between an individual and his environment which is significantly related to preparation for, participation in, or retirement from work. More particularly, those interactions stimulated by the demands of the vocational developmental tasks. (24:131)

Vocational development is the process of growth and learning which subsumes all instances of vocational behavior. The progressive increase and modification of a person's capacities and dispositions for particular kinds of vocational behavior and of his repertoire of vocational behavior. In this sense, vocational development encompasses all aspects of development which can be identified as related to work. (24:131)

Related Research

The literature search uncovered no studies of changes in educational objectives of engineering students which were delimited in a fashion similar to the present investigation. The absence of such research led to the decision to conduct an exploratory study.

To understand why students leave engineering for other curricula, a prerequisite question was also posed. Why do students choose engineering? The literature reveals that researchers have devoted considerable attention to the broader questions of educational and occupational decision-making. An extensive review of their work proved very helpful in designing this study. As indicated earlier, a thorough discussion of the previous research may be found in the project director's doctoral dissertation. A selected bibliography of related research is included at the close of this report.

CHAPTER II

DESIGN OF THE STUDY

The Population and Sample

The population consisted of all the male students who entered engineering at Michigan State University, Northwestern University and the Madison campus of The University of Wisconsin as first-time freshmen in September 1963. The sample was comprised of two groups--the persisters and non-persisters.

The non-persisters were those members of the population who had been in continuous attendance from September through June during the 1963-64 and the 1964-65 academic years and who had changed majors during that period to non-engineering curricula at their respective institutions while earning at least a "C" cumulative grade point average at the time of major change. A matched comparison group--the persisters--was established by selecting students from the population who had demonstrated the same academic potential as those changing majors but who had persisted in their original choice of an engineering major at least through the beginning of their junior year.

Officials of the three universities agreed that the best single predictor of scholastic success in their engineering programs was quantitative reasoning ability. Overall intellectual aptitude was also viewed as predictive of high performance in their engineering curricula. Accordingly, the measures of these intellective characteristics already in use at the three institutions were adopted as the basis for constituting the comparison group. At Wisconsin and Michigan State, the individual matching of persisters to non-persisters was based on the numerical and total scores of the College Qualification Test. At Northwestern, the mathematics and total scores of the Scholastic Aptitude Test were used for the matching.

At Northwestern and Wisconsin, 35 students and 56 students, respectively, were identified as meeting the criteria for membership in the non-persister group. All of these students were designated as subjects to be included in the study. At Michigan State, 109 students met the criteria for non-persisters. To reduce this number to one amenable for study, 72 subjects were selected randomly from the 109 students eligible. Equal numbers of persisters were then identified at the three institutions as described above.

Generally, only one persister was identified to match each non-persister on the basis of academic aptitude. At Wisconsin, however, the pool of students eligible for the persister group was large enough to permit the designation of a primary and an alternate subject in 50 instances of the 56 matchings. In those cases when a primary persister did not choose to participate in the study, the alternate persister was then invited to do so. This device was employed to maximize the number of participants. As it developed, 15 of the alternate persisters subsequently received questionnaires.

A pretest group was established to permit sufficient tryouts of the questionnaire and the interview guide. The pretest population consisted of all the male students who entered engineering at Michigan State University as first-time freshmen in September 1962. The non-persisters were those seniors who had been in continuous attendance since their matriculation (excluding summers) and who had changed majors during their freshman or sophomore year to non-engineering curricula while earning at least a "C" cumulative grade point average. Sixty-two students met these criteria for non-persisters. The persisters were chosen from the pretest population in a manner similar to that described above for the regular study group. Thus, the total pretest group numbered 124 subjects.

Instrumentation

Two instruments--a questionnaire and an interview guide--were designed to gather the data relevant to the purpose and goals of the study as discussed in the first chapter. The following objectives were structured to give direction to the development of these instruments:

1. To assess the nature and importance of each student's pre-college experiences on his educational and vocational decision-making:
    a. the family--its socioeconomic status, parents' attitudes and values, its meaning in the life of the student, the role of siblings, relatives and neighbors, etc.
    b. the school--the impact of courses and teachers, guidance

counselors, other students and extra-curricular activities

   c. work experiences and exploration--part-time and summer jobs; reading about and actively investigating possible career opportunities
   d. other experiences such as the armed forces, unusual opportunities to travel, study or engage in some special activity
   e. the career literature and the mass media
   f. the society in general--its norms and values as seen by the student, the influence of significant others in his life.

2. To assess the nature and importance of each student's college experiences on his educational and vocational decision-making:
   a. the student's initial plans and purposes for studying engineering
   b. the student's initial expectations and aspirations as he embarked upon his college career
   c. the courses and curricula--the student's feelings about the engineering program and his performance in it as contrasted with his attitudes toward other possible alternatives
   d. the faculty--student perceptions of the quality of instruction, the interest of faculty in students and the opportunity for student-faculty interaction and the

meaning of these perceptions to the student

e. the student's peers--their attitudes, values and behavior and their impact on him

f. the academic advising program, the counseling and other personnel services--their nature as seen by the individual student; his use of them and reaction to them

g. the college environment in general--its vital characteristics and its impact on the student

h. out-of-class experiences--extra-curricular activities, part-time and summer jobs, other activities of a special nature

i. special personal commitments of the student--marriage, financial obligations, other personal responsibilities.

A cover letter for the questionnaire was developed to introduce the study, explain its purpose and invite the student's participation. Each subject received a letter personally signed by his respective engineering dean. The text of this letter appears in Appendix A.

The Questionnaire

The purpose of the questionnaire was to collect certain data from each subject and establish a frame of reference for the interview to be conducted later. The questionnaire explored in a preliminary way the personal, family and educational background of the student. It attempted to elicit information concerning those factors which may have prompted him to choose engineering as his original major and his aspirations and expectations in his chosen field. A copy of the questionnaire is included in Appendix B.

A pretest of the questionnaire at Michigan State proved the form to be a satisfactory one for the purpose of this study. Accordingly, no substantive changes were made when preparing it for use with the subjects in the regular study group.

The Interview Guide

A private, 30-40 minute, in-depth interview was viewed as the principal data gathering technique for the study. In developing the interview guide, primary recognition was given to the central purpose of the investigation--to discover why proficient engineering students often change majors to other fields. This question inevitably, and appropriately, required an exploration of why the students chose engineering originally. A semi-standardized interview guide was constructed to help answer these and other related questions. Appendix C contains a copy of the interview guide. A detailed discussion of the rationale underlying the construction of the questionnaire and the interview guide is contained in the project director's doctoral dissertation.

As a result of the pretest at Michigan State, a number of minor revisions were made in the interview guide. This experience also suggested more effective approaches to be used by the interviewer. The alterations in the instrument have been incorporated in the form presented in Appendix C.

Data Collection Procedures

Following the pretest of the instruments, the questionnaires were administered and the interviews conducted at the three campuses according to the time schedule which appears in Appendix D. The deans of engineering used their respective letterheads for the cover letter which accompanied each questionnaire. Also enclosed was a stamped, pre-addressed envelope to be used by the student for mailing the questionnaire if he agreed to participate in the study. All questionnaires were returned directly to project headquarters in East Lansing and were immediately designated by a subject identification number to protect the anonymity of the respondents.

On each campus, a project research assistant was employed who was not otherwise connected with the university. This assistant telephoned subjects who did not return questionnaires by the stipulated due dates to inquire if they planned to participate. Care was taken to avoid pressuring students to do so. However, any questions concerning the project were answered in an interested, positive manner. The research assistant also telephoned the subjects who had returned questionnaires to establish interview appointment times convenient to them and the project director. Postcard reminders were sent to the students so as to arrive two days in advance of their appointments. The interviews were conducted in quiet, convenient locations on each campus. Electronic tape recordings were made of the interviews to facilitate subsequent analysis of the data.

Analyzing the Data

The questionnaire was designed so that much of the data it gathered could be quantified and coded for computer processing. Appropriate statistical techniques were identified for use in analyzing these data.

The data gathered in the interviews were necessarily quite subjective in nature. Several steps were taken to maximize the reliability and validity of the analysis of the interview data. First, an electronic tape recording was made of each interview. Case notes were subsequently prepared using the recordings to provide the information required. Finally, the case notes were used as the basis for a content analysis of the interview data. The interview guide served as the format for this analysis. The results were coded and placed on data cards for processing by the computer. Frequency counts and percentage distributions were obtained which enabled the investigator to compare and contrast the interview responses of the persisters and non-persisters.

CHAPTER III

THE FINDINGS

The Questionnaire Data

The extent of participation of the subjects in both the questionnaire and interview phases of the study is summarized in Table 1 of Appendix E. Of the 326 students invited to participate, 221 or 68 percent returned usable questionnaires--95 persisters and 126 nonpersisters. Appropriate statistical analyses indicated that the respondents were representative of the sample originally identified for study. A description of these analyses, a detailed discussion of the rationale underlying the construction of the instruments and a thorough account of the statistical analyses of the questionnaire data are presented in the project director's doctoral dissertation.

Many of the statistical analyses revealed no significant relationships between the independent variables and persistence in engineering curricula. For the sake of brevity, only the most noteworthy findings from the questionnaire data will be discussed here. However, all of the contingency tables prepared for the statistical analyses are included as Tables 2 through 28 of Appendix E of this report for the reader's use and convenience.

Discussion of the Questionnaire Data

The data elicited by the questionnaire were carefully analyzed to identify variables which may be causally related to persistence or change in major field of study of engineering students. Interpretation of the findings must take into account the considerable homogeneity of the sample. All subjects chose engineering majors at the time of their matriculation. In addition, the selection criteria restricted the non-persister group to those students who had "C" or better grade point averages at the time of major change. Also, persisters were matched with non-persisters on the basis of academic aptitude. These requirements substantially reduce the likelihood of finding significant differences between persisters and non-persisters. The problem is further complicated by the use of a questionnaire which was intended only to appraise global characteristics of the respondents. No claim is made for its sensitivity as an instrument for personality assessment or other sophisticated measurements. In light of these limitations, it is perhaps not surprising that only a few variables were isolated which were related to persistence in engineering curricula.

In Table 11, it was found that persisters more frequently have fathers whose occupations are ranked at the lower or upper extremes of the occupational prestige scale. These data suggest three socioeconomic class groupings: working class, lower middle class, and upper middle class. Hence, it is the lower middle class students who are most inclined to change majors out of engineering.

The results reported in Table 17 indicated that non-persisters accord far more importance to social status and prestige than do persisters. As those who leave engineering are more frequently lower middle class students, one might suspect that they hold this value more strongly than members of the other social class groups. Further analyses reveals that this turns out to be the case. This trend is particularly clear within the lower middle class group. Of these students, 41 percent of the non-persisters attach great importance to social status and prestige while only 23 percent of the persisters hold this value.

These findings lead to the formulation of an hypothesis regarding the motivation of young men from lower middle class homes. The need for upward social mobility may be a primary factor underlying college attendance for these students. If so, they might well be most concerned with earning a college degree as the means for realizing this goal of upward mobility. The engineering degree is not an essential element in this plan. This rationale serves as a partial explanation for the high proportion of lower middle class students who leave engineering. However, this is not to suggest that the non-persister concerned with social status is seeking a more prestigeful occupation than engineering. He may simply feel more free to change majors providing he continues to maximize the chance to achieve his primary goal: that of securing a college degree irrespective of field.

A word should be said concerning the social mobility needs of students from working class and upper middle class homes. The findings of this study suggest they play a less influential role for these students than for those from lower middle class families. It can be reasoned that the social status of the upper middle class student is almost assured by virtue of his birth. Therefore, a college degree per se may have less importance for him and a specific field of endeavor may be of much greater importance. He is "free" to choose a major based on the substantive nature of the curricula available. Working class students also attach little importance to occupational social status and prestige. It is likely that the subculture from which they come does not assign status primarily on the basis of occupational roles. Therefore, this consideration is of less concern to the working class student.

In Table 5, it was found that students from suburban high schools were more inclined to persist in engineering curricula than students from high schools located in central cities or non-metropolitan communities. This is due principally to the fact that two-thirds of the upper middle class respondents were graduated from suburban high schools. However, the tendency for suburban high school students to persist in engineering cannot be explained entirely on this basis. A disproportionate number of working class and lower middle class students also come from suburban high schools. It is hypothesized that suburban high schools--more frequently than city high schools and non-metropolitan schools--have teachers, curricula and facilities which stimulate a deep interest among students for the scientific enterprise and prepare them well for their studies in this area.

From Table 17, it was noted that non-persisters attach more importance than persisters to the opportunity to work with people rather than things. Changes of "people-oriented" students out of engineering are consistent with the research findings reported by Rosenberg, Holland and others. It is believed that students make changes in their fields of study which result in greater consonance between their personal values and the values held by those already in their newly chosen fields. Further efforts by the present investigator to employ Rosenberg's concept of value complexes to help explain the findings of this study were only partially successful.

The data suggest that early consideration of a scientific career is associated with remaining in an engineering curriculum. (A point biserial correlation of -.23 between these variables was statistically significant at the .05 level.) This finding is in harmony with the results of many studies bearing on time of decision-making for scientific and engineering careers. It is speculated that early consideration leads the individual to a deeper commitment to his choice. Also, due to the effects of anticipatory socialization, the student cannot "see" himself in any other occupational role. Thus, he is more likely than the less committed student to persevere in an engineering curriculum even though his academic program may become quite rigorous.

In analyzing the questionnaire data, many of the results showed no significant relationships between a variety of independent variables and persistence in engineering. Of these, the findings reported in Table 20 are particularly noteworthy. This table summarizes the participation of persisters and non-persisters in several high school extracurricular activities. One might find it especially surprising that equal proportions of both groups were active in science clubs and JETS (Junior Engineering Technical Society). It was expected that more persisters would have been involved in such science-related organizations. Conversely, certain activities were viewed originally as having less attraction for scientifically-inclined boys: dramatics, publications, speech, student government, and foreign language clubs. However, no significant differences were found between persisters and non-persisters with respect to their participation in any of these activities. One must observe that there is a remarkable similarity among these students in terms of their high school activity patterns. One wonders whether this holds true for students in other academic disciplines.

The Interview Data

As indicated in Table 1, 326 junior level students at the three universities were invited to participate in the study. Interviews with the project director were successfully scheduled for all but six of the 221 subjects who returned questionnaires. A total of 34 subjects did not appear for their appointments because of the following reasons: forgetfulness, part-time work, the need to prepare for classes, and other unknown causes. Five interviews could not be analyzed due to low tape recording volume and loss of certain tapes through theft. Thus, usable interviews were conducted with a total of 176 students--104 persisters and 72 non-persisters.

The interviews were structured in accordance with the semi-standardized interview guide described in Chapter II and included as Appendix C. The report of the findings which follows is an attempt to summarize qualitatively the feelings, attitudes and reactions of the students to their pre-college and college experiences. It is based on the original comments of the students and the results of the content analysis performed. (2) Tests of statistical significance have not been used nor does this report limit itself to describing only those views held by a large number of students. Rather, its purpose is to highlight potentially meaningful factors and attributes--suggested by only a few students or many--which may be of interest to those concerned with the problem of engineering attrition.

Reasons for Choosing Engineering

An important aspect of the study was the effort made to understand why students select engineering as their major. Such an understanding provides the necessary frame of reference for interpreting their subsequent behavior. When this question was posed in the interview, almost all of the students mentioned the influence of science and mathematics. Proficiency and interest in these high school courses were clearly primary factors leading them to study engineering. Only a few respondents cited shop courses, mechanical drawing or occupations courses as having been influential in their decisions.

Teachers and counselors apparently played a minor role in influencing the students toward engineering. While many of the respondents described warm, positive relationships with some of their teachers, only a small proportion of them indicated that these teachers had a significant impact on their engineering plans. Of these, mathematics and science teachers were the most influential.

Of note is the small number of students who volunteered comments on the role of their guidance counselors. A very few respondents perceived their counselors as having been helpful in their career planning. Students reported that counselors "assumed I would go into engineering because of my high grades in math and science. They said, 'Engineering is meant for you!' My teachers and everybody seemed to feel the same way, so that's what I did." Aptitude and interest tests were seldom seen as useful. "They (the tests) just told me math and science were my strong points." Through the use of a specific follow-up question, it was learned that many students had no assigned adviser during the first three years of high school. Even then, the senior year guidance program, as described by one student, sometimes amounted to no more than the question, "Where are you going to college next year? I have some catalogs if you want to look through them." Frequently, students having assigned advisers throughout the four years of high school saw their lack of availability as an indication of their lack of genuine interest in providing needed counsel. Unfortunately, a large number of students reported that "only a few teachers or counselors seemed to know what engineering really was about." Many students admitted, "I really didn't know what I was getting into, but it sounded like the right thing to do."

High school students perceive engineering in a variety of ways and embark upon their degree programs for a number of different reasons. Many students mention the monetary gains which they believe can be realized from an engineering career. Others emphasize the financial stability and security which come from having a high-paying engineering job. Other students admit that they are attracted to the field due to the prestige which it confers. A few students frankly reported that they were attracted by the mystique and glamour of engineering. It is noteworthy that a larger percentage of non-persisters mentioned these job characteristics than did persisters. The subjects' comments also made it clear that a significant proportion of engineering freshmen simply intended to use their engineering training as a background for careers in other fields. These students are much more likely to change out of engineering if they do not find that it is interesting and meets their expectations.

As might be expected, the strength of commitment to an engineering major appears to be related to persistence in the program. Students who reported they "had little (occupational) information, but knew I could change majors if it didn't go well" were seen as less committed than those who said, "It was a logical choice, the thing to do," or that they "had never considered anything else." A substantially larger proportion of non-persisters than persisters was classified on this basis as being among those who were less committed. Conversely, a larger proportion of persisters than non-persisters offered comments that indicated they were quite committed to engineering.

Hobbies and leisure-time activities also distinguished students who left engineering from those who remained. Persisters tended to report more frequently that they had engaged in mechanical or scientific hobbies during their high school days. These activities included such things as science club undertakings and individual projects initiated and carried out at home. Further exploration of this matter revealed another pattern of behavior uniquely different from that of pursuing a hobby. Many students reported an inclination "to tinker around the house." It is noteworthy that persisters, far more frequently than non-persisters, said they enjoyed repairing things and thinking about how they worked. While persisters described such spontaneous activities in a variety of ways, it was evident that they possessed an attribute--perhaps curiosity--not characteristic of most non-persisters.

The role parents have played in the educational decision-making process of these students is not altogether clear. The comments leave little doubt that the father, rather than the mother, typically takes the lead in opinion-setting in this matter. A substantial proportion of the respondents said that their families supported college-going, in general, without indicating a strong preference for a specific field. Students whose fathers are engaged in engineering frequently reported receiving encouragement to choose a scientific or engineering major. These students seemed to have discussed their future plans in detail with their fathers, reviewing a number of educational and career alternatives. Almost every one of these respondents indicated that his father was pleased he had decided to study engineering.

The dynamics of the family's involvement appeared to be quite different in those instances where respondents' fathers are not engaged in engineering-related work. These students report less frequently that they discussed their future plans with their mothers and fathers. Their comments suggest a less specific involvement on the part of the parents in the career decision-making process. Frequently, the extent of their participation was to simply encourage their children to go to college. For example, one student reported receiving the following advice from his father, "Just get that degree! Than you'll be all set." In comparing the responses of the persisters and non-persisters, it appears that students from "engineering homes" tend more frequently to "stick with" their engineering programs.

A majority of the students interviewed reported that relatives, friends and community influences were important in their choice of an engineering major. Many of the respondents said that brothers, uncles and cousins exercised great influence on them in favor of that decision. Often these relatives themselves were engaged in engineering work. Sometimes they were completing engineering degrees during that period when the respondents were finalizing their educational plans. Without doubt, in this study the influence of students' relatives was substantial--perhaps more so than that of the fathers.

A word should be said concerning the influence of other factors which one might expect would aid a student in clarifying his educational and vocational objectives. Somewhat surprisingly, respondents only infrequently indicated that part-time and summer jobs, science and engineering institutes, and club activities led them toward the choice of engineering. It must be recognized, however, that few subjects had the opportunity to engage in work related to engineering prior to beginning college. Also, only a small number of respondents actually attended summer institutes for the science-minded high school student. Those who did found them very helpful and enthusiastically recommend the expansion of such programs.

At the conclusion of the first part of the interviews, students were asked what prompted them to select their respective universities. Their most frequent reply was "the quality of the academic program." Another influential factor was their familiarity with the school due to their parents, friends or relatives having once been in attendance. As has been found in other studies, financial considerations, geographic location and physical facilities were viewed with varying degrees of inportance. A significant proportion of the respondents indicated their choice of institution was heavily influenced by such factors as a nice campus, modern facilities and an evident interest in the individual student.

Reactions to Engineering Programs

The second part of the interview provided each student with the opportunity to discuss the experiences he encountered during his engineering program. Respondents were first asked to describe their general recollections of the freshman and sophomore years. Then, specific attention was focused upon the curriculum, the courses, instruction, academic advising, and life outside of class. The reasons for leaving engineering were explored with non-persisters and the current attitudes of both groups toward their present academic programs were reviewed.

In commenting upon their freshman year, many students exclaimed, "Hectic--a rude awakening!" The question frequently triggered a flood of memories of a period in the student's life which was pregnant with meaning for him. It had been a time of excitement, of challenge, of doubt and of questioning. New friends, new demands, new ideas, new values--traditional standards, old loyalties and deep-seated aspirations all crowded into one terrifying, wonderful year! For many the transition to college was difficult and threatening. For others it was relatively easy--almost a letdown. But in one matter they almost all agreed: the engineering curriculum was an excruciating and relentless taskmaster. Over and over again the students recalled how they spent night after night "grinding out" solutions to their mathematics, chemistry and physics problems while their dormmates "took off" for coffee dates, intramural sports, concerts or just a "night out with the boys." Some of the respondents frankly admitted that they had to learn how to study (for the first time!) and how to organize their time effectively. Many were particularly chagrined that the demands of their studies severely limited their social lives.

Beneath the surface of the pleasure and excitement of the freshman year, a thread of anxiety and tension was identified. Persisters and non-persisters commonly remarked that they were worried about grades and that they feared "flunking out right off the bat." Students were angry and frustrated with the seemingly unrealistic demands which were made of them in many of their courses before they even had time to get their feet on the ground. The scholastic efforts required of them appeared even more incongruous when compared with the demands faced by their roommates and friends in other curricula. Although they undoubtedly did not let on at the time, many engineering students found the freshman year a period of self-doubt and deep discouragement. A small number of respondents made the candid admission that they had felt very unhappy, lost, or lonely that first year. Conversely, about one-third of the persisters (and fewer non-persisters) reported that they were basically happy or satisfied during their freshman year. Considering the responses in toto, it is noteworthy that such a small proportion of those who remained in engineering recall having enjoyed their first year in college.

The sophomore year was a better one for most all of the students. Persisters reported being happier and better adjusted than as freshman. They enjoyed their courses more, broadened their extra-curricular life and, in some cases, did better academically. Persisters were gratified to finally get to some engineering courses while non-persisters often became quite discouraged with their engineering programs. As their course work became more difficult and more demanding, the non-persisters began giving more serious consideration to the possibility of changing majors. As they left engineering, it is not surprising to find that they began to see their new programs as being more attractive and less demanding. Their comments suggested the welcome emotional release which they experienced at making the change. Quite clearly, the pressures which had built up during their stay in engineering had approached their maximum tolerance levels. Similar pressures were evident among persisters, but they had found effective ways of coming to grips with these tensions of the freshman year. It is the ability to meet these demands successfully which differentiates persisters from non-persisters.

The engineering curriculum came in for criticism by those who remained in engineering as well as by those who left. A significant proportion of both groups saw the curricula at their respective universities as being too narrow and too inflexible. They felt that little opportunity is provided to adapt the curriculum to an individual's needs and desires. Typically, it was the successful student who felt most constrained and frustrated by the rigid sequences of prescribed courses which confronted him at the outset of his college career. These better students indicated they would have preferred greater freedom to choose a few courses of particular interest to them. The opportunities for electives were "too few and far between." Honors programs, advanced placement, and credit by examination provided welcome, but insufficient, relief from the stifling rigidity of their engineering programs.

Another dimension of the curriculum problem is the delay perceived by students before they are able to enroll in "real" engineering courses. A large number of respondents mentioned the frustration of "always preparing for something which you never seem to get to." The problem here lies in the fact that students do not view mathematics, chemistry, and physics as engineering courses, but rather as somewhat peripherally-related preparatory activities. Indeed, this is the case. The students long for the opportunity to begin their engineering work in the electrical circuits course, the mechanics sequence, or the electromechanics course. However, all of these build from the foundation laid by mathematics and the engineering sciences during the first year of study. Hence, the frustration of delayed gratification in engineering education. More will be said concerning these and other problems which seem to arise from the unique nature of the engineering curriculum.

Respondents were next asked how they felt about the individual courses required of engineering students. A majority of the persisters replied that most or all of these courses seemed appropriate and relevant. However, a significantly smaller proportion of these students indicated that they found their courses enjoyable or interesting. Conversely, only a small percentage of the non-persisters found their engineering courses meaningful and enjoyable. Students also appraised the quality of instruction provided by professors and recitation instructors. A majority of the persisters felt that most of their teachers should be rated from good to excellent. Only a few non-persisters held this view. In addition, the respondents pointed out several problems of instruction which bothered them. Some indicated their "professors knew the material but couldn't get it across." Others said their professors appeared to be more interested in research than in students. Large classes were seen as being detrimental to learning as were foreign instructors who had not successfully coped with the English language barrier. Mathematics, chemistry and physics drew the largest number of specific reactions from the students interviewed.

Mathematics proves to be the nemesis of a majority of the freshman and sophomore engineering students. A substantial proportion of both persisters and non-persisters perceived their calculus courses as inappropriate and of little relevance to their future needs in engineering. Many students expressed the view that mathematics was not an enjoyable experience for them, that it was uninteresting and unnecessarily rigorous. A large proportion of these students rated their mathematics professors as very poor while only a few judged them to be good or excellent. Frequently, criticism was leveled at the lack of applications used to illustrate the theoretical principles being studied. Although students generally did not mention the quality of instruction provided by recitation instructors, a notable exception was mathematics. A significant number of respondents indicated that it was frequently the recitation instructor who "got them through" a mathematics course taught by an indifferent or ineffective professor. Proportionately more non-persisters indicated that these courses were extremely difficult for them while more persisters directed their criticism to the irrelevancy of the material covered.

Chemistry and physics also played a critical role in a student's decision to remain in or leave engineering. It was interesting to note the variability of their reactions to these courses from school to school. Apparently student opinions of these areas of study are conditioned principally by the personalities of the professors rather than the substantive content of the courses. The enthusiasm and interest of a skillful teacher often taps a reserve of boundless energy which the student happily directs toward the learning process. Such vital relationships between students and faculty were evident at all three institutions, but in disappointingly small proportions. The persisters more frequently expressed satisfaction with their chemistry and physics courses while non-persisters tended to find them uninteresting or unnecessarily rigorous.

Students commented only infrequently about the other courses studied during the freshman year. Few positive or negative reactions were offered by respondents with respect to their general education courses and engineering drawing. Freshman English elicited few expressions of satisfaction but drew the hearty disapproval of a significant proportion of the students, especially the persisters.

Sophomore engineering courses--such as statics, dynamics, electrical circuits, and electromechanics--played an important role in the lives of the students interviewed. Substantial differences can be seen between persisters and non-persisters with respect to their reactions to these academic experiences. A large number of the students who remained in engineering were enthused by their first technical courses. A significant percentage of these students said their courses were interesting and enjoyable. Although some felt they were quite rigorous, the persisters generally found the material appropriate and challenging. Many of these students also rated their professors in these sequences as good or excellent. Few of the non-persisters reported similar positive reactions to their sophomore technical course work. It appears that for those students who made it into their second year, the engineering courses then provided the basis for deciding whether to change majors or continue with their original plans to secure an engineering degree.

Students apparently relied little upon the guidance of their academic advisers during their freshman and sophomore years. Only a few students reported having an active, close relationship with their advisers. As one student commented, "He's never around when I need him and, when we do meet, we end up reading the catalog together." Dissatisfaction with the academic advising program ran high among both persisters and non-persisters. Most students indicated that their relationships with their advisers could be best described as passive, distant, and procedural in nature. In fact, some students felt that their academic advisers were indifferent to their needs and problems. At Michigan State University, students indicated that a new approach to academic advising may provide the means for overcoming some of these problems and stimulating greater enthusiasm for and commitment to their educations. (20) It is significant that, while few students from the participating institutions found their advisers helpful in dealing with the various problems of college life, an equally small proportion sought out other university resources such as the counseling service and other members of the faculty.

Where then did these students go to seek guidance and support? The interview data reveal, not surprisingly, that the respondents most frequently turned to their friends and roommates for advice and understanding. As a result, acquaintances established through a student's living arrangements exercised great influence in the formation of the student's occupational and life values. Fraternities and other extracurricular activities were cited by some as having prompted their decisions to change majors. Other students, however, cite these same influences as supportive of their plans to remain in engineering. This evidence reinforces the belief that a student's social milieu has a significant impact on his total development, particularly with respect to his educational and career goals.

Summer jobs often aided students in clarifying their occupational objectives. Those who were able to find work related to engineering during the summers following their freshman and sophomore years reported almost unanimously that these experiences had proved very worthwhile. As one student put it, "It was great just to find out what engineers do all day!" Both persisters and non-persisters said their jobs helped them to reassess their future plans. Some concluded that they should change majors before "getting in any deeper." Those who remained in engineering returned to their studies with a new enthusiasm and dedication. The same phenomenon was observed operating with the Northwestern engineering students who were following the cooperative work-study curriculum. All of these men were outspoken proponents of getting some "on-the-job experience." Many said, "It really helps a lot to see how all that theory is used to get a job done!" These students returned from their work assignments not only with a deeper appreciation for the engineering field, but refreshed due to the break from classes and the opportunity to fend for themselves.

The final portion of the interview was devoted to exploring student reactions to their engineering programs and identifying the perceived reasons non-persisters changed majors. As mentioned earlier, a majority of all the students interviewed found the curricula far too specialized and inflexible. They felt that the "narrowness" of the programs carries over into the image of the stereotyped engineering student as one who only sleeps, eats and "books it." These impressions, coupled with the desire to explore the world of ideas more thoroughly, accounted for the attrition of many of the subjects interviewed.

A large proportion of the respondents expressed surprise at the content of the individual courses required in engineering. Their high school work and the people with whom they had discussed their plans had provided no clues as to what they would encounter. Similarly, students reported that their preconceptions of the engineering field were equally inaccurate and ill-founded. As they became better informed, many students altered their educational plans. It is noteworthy that these decisions were often made before they had taken any engineering courses.

A significant number of the non-persisters changed majors simply because they found the technical courses too difficult for them. Although all of these students were earning above "C" averages when they left, they frequently commented that their performance had not met their own expectations. Some felt they did not possess the necessary ability or preparation to succeed in their engineering programs.

As suggested earlier, engineering serves as an "undergraduate training ground" for many students who plan to go on to careers in a variety of other fields. Management, sales, law and medicine are but a few of the goals toward which some engineering students aspire. Should their expectations be violated and should they find their engineering courses uninteresting or irrelevant, it is not surprising that they shift the field in which they do their preparatory work. In a similar vein, some students originally committed to engineering develop the desire to explore other career opportunities. This is frequently the natural outgrowth of their expanding knowledge of the world of work. Such patterns of vocational behavior might well be viewed with less concern by engineering educators than at present.

High percentages of both persisters and non-persisters expressed satisfaction with their academic programs at the beginning of their junior year. Those who remained in engineering were happy that they did so. They seemed particularly enthused because of the advanced engineering course work upon which they had recently embarked. Those respondents who had changed majors displayed equal enthusiasm for their new endeavors. Large proportions of both groups said they hoped to go on to graduate study at the earliest opportunity. The long-range occupational plans of students reflected a diversity of fields encompassing private industry, education, government service, the military and several professional careers.

Discussion and Summary of the Interview Data

The complexity of educational and vocational decision-making is widely recognized. The interviews conducted as part of this study have had the modest objective of suggesting some of the feelings, attitudes, and reactions experienced by students during the early years of their engineering programs. Further, it was hoped that a more sensitive understanding of the needs and problems of engineering students would result and that the causes of engineering attrition would become more clearly apparent.

The present investigator interviewed a total of 176 students--104 persisters and 72 non-persisters. A semi-standardized interview guide provided the amount of structure desired to facilitate subsequent analysis of the interview data. The findings reported in this chapter are based on a content analysis of the case notes prepared from electronic tape recordings of the interviews.

Many influences impinge upon high school students as they choose their college majors. Respondents almost unanimously reported that their choice of engineering was prompted principally by the success and interest which they had demonstrated in their high school mathematics and science courses. Teachers, guidance counselors and parents frequently reinforced the belief that this was a "sure fire" indication of the appropriateness of engineering. Students were troubled, however, by the realization that they knew little or nothing about the career upon which they presumably were embarking. Their confusion was heightened by the encouragement of advisers who themselves "didn't know what engineering really was about." It appears that eventually the students succumbed to the many urgings and plunged ahead, hoping for the best.

Students told of family influences which directed them toward engineering. Fathers, brothers and other male relatives frequently played a critical role. There is a tendency for students whose fathers are engaged in engineering to persist in their engineering programs. The converse also appears to hold: students whose fathers are not engaged in engineering-related work but who attributed great influence to their fathers tend more frequently to change majors. Perhaps this is a function of the better-informed counsel which is provided by fathers who are engineers. Also, this may be further evidence that social mobility needs prompt students from lower middle class families to prioritize most highly the securing of a college degree *per se*, regardless of field.

Respondents who had pursued mechanical or scientific hobbies more frequently remained in their engineering programs. Also, it was discovered that "tinkering around the house" was related to persistence in engineering. It was the persisters--more often than the non-persisters--who said they enjoyed repairing things and thinking about how they worked.

The research reviewed has suggested that commitment to an engineering major should be related to persistence in the program. The interview and questionnaire data both support this belief. Many of the persisters offered comments indicating they were rather deeply committed to engineering at an early age. Conversely, the non-persisters more frequently explained the choice of engineering as an exploratory venture or a convenient decision. The questionnaire data also provided evidence that early consideration of a scientific career is associated with remaining in an engineering curriculum. If indeed early consideration leads to deeper commitment, these findings complement each other and provide further support for the theory that persistence is a function of commitment.

A variety of other considerations sometimes plays a role in the decision to study engineering. Respondents reported that monetary gains and the prestige and glamour of the field influenced their planning. Also, it was established that, as freshmen, a substantial proportion of the respondents had intended to use their engineering training simply as a background for careers in other fields. It would seem appropriate for engineering educators and counselors to give greater cognizance to initial plans of students when assessing causes of engineering attrition.

In discussing their reactions to their engineering programs, students recited vivid accounts of their freshman and sophomore years. Many recall their first year as "hectic--a rude awakening." They found it a turbulent, exciting and challenging period full of new friends and new experiences. The demands of the engineering curriculum were a sobering influence in this free-wheeling, socially-minded atmosphere. Engineering students felt tense and anxious as they would drop further and further behind in many of their class assignments. The frustration was often intensified by a friend's or roommate's freedom from comparable requirements in some other curriculum. Mathematics courses and professors contributed significantly to the frustration and anguish of these early years in engineering. Depending upon the institution, chemistry or physics might further contribute to the student's dissatisfaction with his academic program. For many students, the freshman year was one of doubt and discouragement. It is noteworthy, and should be of some concern to engineering educators and others, that fewer than one-third of the students who had remained in engineering reported they had been basically happy or satisfied during their first year of college.

Almost all of the respondents indicated an improvement in their social and academic lives during the sophomore year. Although persisters and non-persisters shared a keen distaste for their highly-structured, inflexible curricula, those students who persisted in the program apparently came to accept this as a "fact of life." Non-persisters, on the other hand, grew more and more disenchanted with their engineering programs and eventually made the decision to change majors. The sophomore engineering courses proved to be critical turning points for members of both groups. Persisters were gratified to finally get to the courses for which they had been preparing. The lack of satisfaction experienced by non-persisters confirmed their inclinations to leave engineering.

The interviews revealed additional influences which affected the students' educational and career plans. Summer jobs related to engineering helped students to clarify and reassess their future goals--prompting some to change majors while confirming the plans of others. Similar advantages were realized from the cooperative work-study program at Northwestern University. Students not only learned what realistic requirements they would have to meet on the job, but they consistently returned from their work assignments with heightened enthusiasm for their studies.

The lack of influence of the academic advisers was striking. Persisters and non-persisters alike criticized their unavailability, their lack of relevant and current information and their frequent lack of interest in the advising task. A large proportion of the students reported the relationships with their advisers as passive, distant and procedural in nature. An experimental advising program using full-time guidance personnel at one of the schools elicited favorable comments from many students.

Respondents indicated that they turned most frequently to other students for advice and understanding. Individual friends and peer groups played an important role either in sustaining interest for engineering or prompting changes of major. As a result, the full impact of the primary friendship group within the residence hall, the fraternity, the student engineering society and other extracurricular activities came to be appreciated more completely.

Extensive consideration was given to the reasons expressed by non-persisters for leaving engineering. A majority of all the respondents found the curriculum far too specialized and inflexible. This view was held frequently by the superior students. They seemed to feel constrained intellectually and longed for the opportunity to partake of the "academic smorgasbord" available at their respective universities. Some did so by changing majors. Other students altered their educational plans due to the violation of their expectations concerning the course content of the engineering curriculum and the nature of the work encompassed by the engineering profession. A significant number of non-persisters left engineering simply because they found the technical courses too difficult for them. They admitted they "just couldn't cut it!" Finally, it was recognized that because engineering serves as an "undergraduate training ground" for several other fields, engineering educators might well expect students oriented in those directions to change majors more frequently than students dedicated to the engineering profession. It should also be expected that major changes will naturally occur as students decide to explore and verify their expanding knowledge of the world of work.

Both persisters and non-persisters expressed widespread satisfaction with the academic programs they were pursuing as juniors. While virtually all of the respondents were understandably concerned with their draft status, many said that impending military service had not influenced their previously-formed plans to engage in graduate study. The students interviewed saw themselves in a variety of work situations in the future ranging from private industry and government service to education and the legal and medical professions.

CHAPTER IV

CONCLUSIONS AND RECOMMENDATIONS

Findings and Conclusions

Of the 326 students invited to participate, 221 (68 percent) returned questionnaires. Due to the exploratory nature of the study, no hypotheses had been formulated for testing. However, the comparison of the responses of persisters and non-persisters to various questionnaire items implied the following operational hypothesis:

> There are differences between the persisters and non-persisters with respect to each of the variables included in the questionnaire.

Primarily the chi-square statistic was used to determine whether the respective independent variables were related to persistence in an engineering curriculum. The following results were found to be statistically significant.

1. Subjects from working class and upper middle class homes tend to persist in engineering curricula more frequently than those from lower middle class homes.

2. Non-persisters attach proportionately more importance to social status and prestige than do persisters. Further analysis revealed that lower middle class students are those who predominantly hold this value. These findings and the interview results suggest that upward social mobility may be a primary factor underlying college

attendance for lower middle class students. If so, they may be concerned most with securing a college degree per se regardless of field.

3. Non-persisters attach proportionately more importance than persisters to the opportunity to work with people rather than things.

4. Non-persisters, more often than persisters, believe they will find jobs which will provide the opportunity to work with people rather than things. These findings that "people-oriented" respondents change out of engineering appear to be consistent with the evidence gathered by Rosenberg, Holland, and others that students make changes in their fields of study which result in greater consonance between their personal values and the values held by those already in their newly chosen fields.

5. Proportionately more subjects from suburban high schools persist in their engineering studies than do those graduated from central city and non-metropolitan high schools. This finding and discussions with the students suggest that high school climates may have distinctive characteristics which intensify student interests in specific fields. If so, certain influences may be at work which give suburban high schools a more pronounced "scientific orientation" than the high schools found in the central city and in non-metropolitan areas. Research similar to the work of Pace and Stern with college environments might prove fruitful in understanding better the characteristics and impact of high school climates.

6. The age at which respondents first considered the possibility of a career in science or engineering is inversely related to persis-

tence in an engineering program. Taking this evidence and the comments of students into account suggests that early consideration of a career leads to a deeper commitment to the field. The results of this study and other investigations indicate that the highly committed student is more likely to persevere in his decision even in the face of formidable obstacles.

7. Persisters, more frequently than non-persisters, used their own savings to finance their freshman and sophomore years in college. This result was unexpected and is somewhat puzzling. Its appearance is perhaps simply a chance occurrence.

8. Non-persisters have significantly lower grade point averages at the time of departure from engineering than do their matched persisters at similar points in their college careers. It might be reasoned that the non-persisters experienced greater anxiety in connection with their academic programs and questioned more frequently their possible chances of eventual success in both their engineering curricula and in the field itself. These less successful students may have found themselves in an atmosphere of impending scholastic danger, thus prompting them to change their majors. An equally plausible explanation is the assumption that while in engineering, non-persisters found their courses of little interest or challenge. Lacking enthusiasm for their studies, these students failed to mobilize their full intellectual resources and consequently earned significantly lower grades than their counterparts. Both explanations may have merit depending upon the individual student.

9. Of the 73 chi-square analyses, 67 of the values obtained did not reach statistical significance. As they have been reported in the project director's doctoral dissertation, only those negative findings which are considered to be most noteworthy will be mentioned here. It was expected that more persisters than non-persisters would have been involved in science clubs and JETS organizations (Junior Engineering Technical Society). This did not prove to be the case. Nor were differences found between persisters and non-persisters with respect to their participation in dramatics, publications, speech, student government, and foreign language clubs. The findings indicate a remarkable similarity among these students in terms of their high school activity patterns.

Interviews were conducted with a total of 176 students--104 persisters and 72 non-persisters. The findings reported below are based on a content analysis of the case notes prepared from electronic tape recordings of the interviews.

10. Although students choose engineering majors for a wide variety of reasons, the following are among the most common for the respondents in this study:

a) success and interest in high school science and mathematics courses,

b) the encouragement toward engineering received from fathers, brothers, relatives and friends,

c) the interest developed while pursuing mechanical or scientific hobbies and leisure-time activities,

d) extrinsic features such as the monetary benefits, prestige and glamour of the field, and

e) the belief that an undergraduate engineering program would provide a sound background for a career in some other field.

These findings dramatize the intricacies of the educational decision-making process and suggest that the explanations for changes in these decisions may be even more complex and difficult to identify.

11. High school students, teachers, guidance counselors and parents evidently know little about the work of the professional engineer or the nature of the educational programs leading to such careers. As a result, it appears that many of the decisions to enter engineering are based on limited or inaccurate perceptions of the field and curricula.

12. Respondents indicate that the early years of their college programs are often frustrating and anxious periods during which they must work out a multitude of personal and social problems while clarifying their educational and career goals.

13. There is widespread dissatisfaction among students interviewed with the highly structured, inflexible engineering curricula. These feelings are expressed frequently by both persisters and non-persisters.

14. Certain required courses, especially mathematics, antagonize many students and reinforce misconceptions of the nature of engineering work. One concludes that many non-engineering personnel play significant roles in determining the early attitudes and opinions of freshman

and sophomore engineering students.

15. Sophomore engineering courses are welcomed and enjoyed by most students. Both persisters and non-persisters report that these courses were helpful to them in deciding whether to remain in engineering.

16. Friends and acquaintances of respondents play important roles in their decisions to continue their engineering studies or change to other curricula.

17. Large proportions of both persisters and non-persisters report passive, procedural relationships with their academic advisers as being typical throughout their college years. Students apparently made little use of other resources such as the counseling center and other members of the faculty.

18. Engineering-related work experience provided by summer jobs and cooperative work-study programs helps students determine whether they are best suited for and most interested in an engineering career. Both persisters and non-persisters enthusiastically support summer job programs and ask that their universities aid them in finding relevant work situations. These results correspond to the wholehearted endorsement given summer technical work in a recent survey of students, engineering colleges and employers. (22)

19. Non-persisters cite a variety of reasons for changing out of engineering. Those most frequently mentioned include:

a) Students had mistaken impressions of the engineering field.

b) Students were dissatisfied with the content of the required courses.

c) The student's scholastic performance did not meet his self-expectations.

d) Students adopted new career goals.

e) Students felt they could find more appropriate routes to the non-engineering career goals they had originally established.

f) Students wanted to explore other career opportunities. These findings suggest that an unwarranted number of curriculum changes may be caused by misconceptions of the engineering program and the engineering field. On the other hand, much of the switching being done is probably a result of students making positive, healthy reassessments of their personal interests and aptitudes.

Recommendations

The following recommendations are offered by the project director based upon the findings of the study and many of the suggestions made by the students interviewed. (3,4,5)

1. Engineering educators and professional engineering societies should undertake serious efforts to communicate more widely and more clearly the nature of the work performed by engineers and the content of engineering curricula. These efforts should reveal the great diversity of activity within the engineering profession verified in recent national studies. (11,16,25)

2. The various professional engineering organizations should give serious consideration to centralizing and unifying the primary responsibility for providing career information on behalf of the profession. Given the necessary support and cooperation, the Junior

Engineering Technical Society (JETS) could perhaps serve effectively in this role.

3. High schools should assess their total programs to ensure that all available opportunities are realized for helping students to better understand the world of work. In particular, efforts should be made to utilize all resources which aid both students and staff in gaining a deeper appreciation for the nature of engineering. The work of the high school counselor should be integrated with the roles played by mathematics and science teachers in guiding students toward careers in the physical sciences and engineering. Cooperation between high schools and nearby universities, such as the program sponsored by The University of Wisconsin (21), should be promoted to enrich the guidance services available to students.

4. Engineering schools should attempt to clarify for potential students the types of engineering programs which they offer and the responsibilities which their students assume upon graduation.

5. Engineering schools should recognize the unique needs of their freshman students and provide specific programs to meet these needs. A carefully considered freshman curriculum and a qualified counseling staff can promote important individual contacts with students which aid them in identifying with engineering and adjusting to their chosen majors. Some schools have already made progress in these directions. (18,20)

6. A sound, responsive academic advising program should be provided at all levels of a student's formal education. Advisers must be readily

available and give evidence of their genuine interest in their advisees. Their work should be recognized and supported by all members of the faculty.

7. Engineering educators should be alert to the possibilities of reinforcing the commitment freshmen and sophomores have made to the program. Earlier introduction of academic work taught by engineering professors, greater flexibility in course scheduling, efforts to reveal the future possibilities of an engineering career, and activities which help the individual student identify with the engineering school and other engineering students all deserve serious consideration. It is recognized that these suggestions have been offered by others before. (14)

8. Engineering schools should initiate or intensify their efforts to maintain complete records of student turnover if meaningful data are desired to assess trends in engineering enrollments and attrition. Studies of an intercurricular nature are needed to place engineering data in perspective, as is being done in an investigation now underway. (8)

Implications for Further Research

The findings and conclusions stated above suggest questions which merit the attention of future investigators. These questions, outlined below, could be readily translated into operational hypotheses for use in their research.

1. Are the motivations of students from different social class backgrounds related to distinctive patterns of persistence or change in

educational objectives?

2. Do students characterized by different value orientations tend to change majors within and between principal disciplines so as to increase the consonance between their value systems and those of the people already in their newly chosen fields?

3. Does early serious consideration of an engineering career result in a deeper commitment to the field which is later manifest by persistence in an engineering program?

4. Can high schools be identified with respect to the ascendance of distinctive intellectual climates which then predispose graduates to persevere in those college disciplines most closely related to the ascendant characteristics of the respective high schools?

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APPENDICES

APPENDIX A

COVER LETTER FOR THE QUESTIONNAIRE

Note: This cover letter used at Michigan State University is typical of those sent by the deans of engineering at Northwestern University and The University of Wisconsin.

October 28, 1965

____
____
____

____

The College of Engineering has a continuing interest in the academic progress of all of its students, those who have remained in engineering as well as those who have changed to other majors. We are cooperating with two other universities--Wisconsin and Northwestern--in a study intended to explore some of the influences on students who remain in engineering as well as those who transfer to other fields. I hope you will help us by participating in this study.

A grant from the Alfred P. Sloan Foundation has made it possible for us to explore with the 1963 entering engineering classes many of the questions of vocational choice faced by every student in high school. In addition to this concern, we are anxious to learn of the effect which your freshman and sophomore experiences have had upon your educational and vocational planning. We would like you to complete the enclosed questionnaire and follow through with a short interview at a later date. Mr. Roger D. Augustine of our University is serving as the project director and will contact you during the next week or two to arrange this interview at your convenience.

I hope you will be frank in discussing your experiences here at Michigan State. I assure you the information you provide in the questionnaire and interview will be held in the strictest of confidence by Mr. Augustine. He will integrate the comments of all the students in order to identify significant trends and problem areas. These general interpretations will help us to serve better those high school and college students who are considering entering the engineering profession.

I encourage you to participate in this study. If you decide to do so, please fill out the enclosed questionnaire and return it at your earliest convenience to Mr. Augustine in the addressed, stamped envelope provided. Thank you very much for your cooperation.

Sincerely yours,

J. D. Ryder, Dean

JDR/gf

APPENDIX B

THE QUESTIONNAIRE

A STUDY OF THE 1963 ENTERING ENGINEERING CLASSES AT THREE MID-WESTERN UNIVERSITIES

To the student:

Your cooperation in filling out this questionnaire completely and promptly will help your University to serve better the students who are following in your footsteps. Although the questionnaire is six pages long, you will find it requires only a short time to complete. This results from the frequent use of multiple-choice responses. Please feel free to elaborate upon any question if you wish. You may use the back of the questionnaire whenever necessary. The information you provide will be held in the strictest of confidence. As we are most anxious to have your individual opinions, please do not discuss your responses with other people. Thank you very much.

Please mail this questionnaire no later than ______________________.

Name ____ Marital status __________
(Last) (First) (MI)

School address ________________________________ Phone ______________
(Number) (Street) (City)

1. What is the name of your home town? ________________________________
(City) (State)

2. What is the name and location of the high school from which you were graduated?

Name: ____________________ City: __________________ State: __________

3. What was the approximate size of your graduating class? (Circle the appropriate response.)

1. 1-99
2. 100-249
3. 250-499
4. 500-749
5. 750 or more

4. Please specify your age to your nearest birthday. _____ years

5. Do you have any brothers or sisters? Circle one: Yes No If yes, please answer questions 6 and 7 when appropriate.

6. Circle the ages of all your brothers (to the nearest birthday).

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

If others, specify ages: ______________________

7. Circle the ages of all your sisters (to the nearest birthday).

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

If others, specify ages: ______________________

8. What was the highest level of education attained by your father? (Circle the appropriate number or, if he engaged in graduate study, circle the appropriate phrase. Consider any part of a year a full year for this purpose.)

1 2 3 4 5 6 7 8	9 10 11 12	13 14 15 16
Elementary school	High school	College, business school, etc.

Graduate school: Masters or Doctorate or Other (specify): ____________________

9. What is your father's present occupation? (Be specific; for example: Pipe fitter, civil engineer, etc. If deceased or retired, specify last occupation.)
____

10. What was your father's occupation at the time you were born? __________________

11. What was the highest level of education attained by your mother? (Circle the appropriate number or, if she engaged in graduate study, circle the appropriate phrase. Consider any part of a year a full year for this purpose.)

1 2 3 4 5 6 7 8	9 10 11 12	13 14 15 16
Elementary school	High school	College, business school, etc.

Graduate school: Masters or Doctorate or Other (specify): ____________________

12. What is your mother's present occupation? (Be specific; for example: Housewife, stenographer, high school teacher, etc. If deceased or retired, specify last occupation.) ____

13. In which of these four groups do you consider your family to be? (Circle the appropriate response.)

    1. Upper class
    2. Middle class
    3. Working class
    4. Lower class

14. In the future, how do you expect your own income to compare with that of the family in which you were brought up? (Circle appropriate response.)

    1. Higher income
    2. About the same income
    3. Lower income

15. Students usually have many good reasons for coming to college. Rank in order the five reasons that seem most important to you, using "1" to indicate the most important, "2" to indicate the second most important, etc.. You may add others or explain.

1. ___ To get a liberal education
2. ___ To prepare for a vocation
3. ___ For the prestige of a college degree
4. ___ To be with old school friends
5. ___ To make friends and helpful connections
6. ___ For social enjoyment; "College Life"
7. ___ To please parents or friends
8. ___ Family tradition
9. ___ To learn more of certain subjects
10. ___ It was the thing to do, foregone conclusion; I never questioned why
11. ___ Without college training, there is less chance of getting a job
12. ___ Will enable me to make more money

Explanation: ____

____

16. Which of the following best describes your parents' attitude, in general, when you were in high school? (Read the alternatives carefully and circle the number of the most appropriate response.)

1. It was expected that all the children would go to college.
2. Parents encouraged those children who wanted to go to college to do so, but it was not assumed that all would go.
3. It was not assumed that all the children would go to college.
4. Parents discouraged college attendance.

17. Sometimes parents have different attitudes toward a college education for their sons versus a college education for their daughters. Which of the following best describes your parents' attitudes when you were in high school? (Read the alternatives carefully and circle the number of the most appropriate response.)

1. It was assumed that the boys, but not necessarily the girls, would go to college.
2. It was assumed that the girls, but not necessarily the boys, would go to college.
3. It was assumed that children who wanted to go to college should be encouraged to do so.
4. It was assumed that any of the children who wanted to go to college would have to make it without the encouragement of his parents.
5. It was assumed that all children should go to college.

18. In most families, some sacrifice is necessary to make it possible for children to attend college. Looking back, what statement best describes the sacrifice made in your family to permit you to attend college? (Circle the number of the most appropriate response.)

1. no sacrifice
2. small sacrifice
3. moderate sacrifice
4. great sacrifice
5. very great sacrifice

19. Most students have some opinions of what their ideal job ought to be like and what requirements it ought to satisfy. Some of these characteristics are listed below. As you read the list, consider to what extent a job or career would have to satisfy each of these requirements before you would consider it ideal.

Indicate its importance for you by circling "VGI" for very great importance, "GI" for great importance, "MI" for moderate importance and "LI" for little importance.

The ideal job for me would have to:	VGI	GI	MI	LI
a. Provide me an opportunity to use my special abilities or aptitudes.	VGI	GI	MI	LI
b. Provide me with a chance to earn a good deal of money.	VGI	GI	MI	LI
c. Permit me to be creative and original.	VGI	GI	MI	LI
d. Give me social status and prestige.	VGI	GI	MI	LI
e. Give me an opportunity to work with people rather than things.	VGI	GI	MI	LI
f. Enable me to look forward to a stable, secure future.	VGI	GI	MI	LI
g. Leave me relatively free of supervision by others.	VGI	GI	MI	LI
h. Give me a chance to exercise leadership.	VGI	GI	MI	LI
i. Provide me with adventure.	VGI	GI	MI	LI
j. Give me an opportunity to be helpful to others.	VGI	GI	MI	LI

20. Realistically, the job or career one actually selects may not meet all one's requirements for an ideal job. Indicate the degree to which you expect realistically to find these characteristics in the career you have selected or intend to select by circling "VGL" for very great likelihood, "GL" for great likelihood, "ML" for moderate likelihood and "LL" for little likelihood.

I realistically expect the job that I select to:	VGL	GL	ML	LL
a. Provide me an opportunity to use my special abilities or aptitudes.	VGL	GL	ML	LL
b. Provide me with a chance to earn a good deal of money.	VGL	GL	ML	LL
c. Permit me to be creative and original.	VGL	GL	ML	LL
d. Give me social status and prestige.	VGL	GL	ML	LL
e. Give me an opportunity to work with people rather than things.	VGL	GL	ML	LL
f. Enable me to look forward to a stable, secure future.	VGL	GL	ML	LL
g. Leave me relatively free of supervision by others.	VGL	GL	ML	LL
h. Give me a chance to exercise leadership.	VGL	GL	ML	LL
i. Provide me with adventure.	VGL	GL	ML	LL
j. Give me an opportunity to be helpful to others.	VGL	GL	ML	LL

21. About how much money do you expect to earn per year about 10 years after you have completed your formal education--assuming the buying power of the dollar continues at the present level? (Circle the appropriate response.)

    1. $ 4,999 or less
    2. 5,000 - 9,999
    3. 10,000 - 14,999
    4. 15,000 - 19,999
    5. 20,000 or over

22. How old were you when you first considered the possibility of a career in the area of science or engineering? _____ years

23. How old were you when you actually decided to enroll in an engineering school? _____ years

24. What courses did you most enjoy during high school? ____________________

    ____

25. What courses did you least enjoy during high school? ____________________

    ____

26. In what extra-curricular activities did you participate in high school? (Circle all appropriate responses and add any activities you wish.)

    1. Individual sports
    2. Team sports
    3. Science clubs
    4. JETS Club
    5. Musical organizations
    6. Dramatics
    7. Publications (newspaper, yearbook, etc.)
    8. Speech and/or debate team
    9. Foreign language clubs
    10. Student government
    11. Other: ____________________

    ____

27. What hobbies or other leisure activities have you engaged in over the past several years? ____________________

    ____

28. Briefly describe any activities or experiences which you had during or after high school which you feel had a significant effect on your educational or vocational plans. These might include part-time or summer jobs, special science or engineering institutes, other unusual opportunities for study or travel, etc.

    ____

    ____

    ____

29. Prior to entering the University, did you have any personal contacts with people in the field of engineering? Circle one: Yes No If yes, describe briefly their relationship to you (e.g. Uncle, friend of family, etc.) and the nature of their work. ______________________________

____

____

30. What was your department or major in engineering when you entered the University in September, 1963? ______________________

31. What is your present department or major? ______________________

32. If you changed your department or major, when did you do so? (Month)___ (Year) ___

33. What sources of financial assistance did you have during your freshman and sophomore years: (Circle all appropriate responses.)

1. parents
2. relatives
3. scholarship
4. your savings
5. your part-time job
6. your summer job
7. loan
8. other (specify) _______ ______________

34. Please briefly describe your long-range educational goals when you entered the University as a freshman.

35. Have these changed? (Circle one) Yes No If yes, how?

APPENDIX C

THE INTERVIEW GUIDE

THE INTERVIEW GUIDE

Question 1. Let's start off by getting down to a very important matter. Would you try to describe, as specifically as possible, what led you to choose engineering as your college major?

Follow-up questions to question 1.

1a. What about the school? . . the teachers, the counselors?
1b. How about your family? . . parents, relatives, friends?
1c. What about you as an individual?
1d. What about jobs and summer activities?
1e. What else had you been doing?
1f. How about society in general?
1g. When did you actually decide on an engineering major?
1h. What prompted you to attend this University?

Question 2. Moving now to your college days, how do you feel about the experiences you had during your first two years of school? Would you describe them for me a little?

Follow-up questions to question 2.

2a. What were your plans originally?
2b. What did you expect?
2c. How about your courses? . . your view of their relevance in your curriculum?
2d. What about the faculty? . . the quality of instruction?
2e. How about the academic advising program?
2f. How about the non-academic personnel (counselors, residence hall staff, etc.)?
2g. What about life outside-of-class?
2h. Any special pressures or responsibilities on you?

Question 3a. For those who changed majors: Would you try to tell me why, exactly, did you change to ________________? (his new major) How do you feel about your present course of action?

Question 3b. For those who remained in engineering: How do you feel about your engineering program right now? In what ways has it met or exceeded your expectations? In what ways has it not?

Question 4. What suggestions would you like to make that would help the University and engineering better serve the needs of high school and college students?

APPENDIX D

TIME SCHEDULE FOR DATA COLLECTION

TIME SCHEDULE FOR DATA COLLECTION

Fall, 1965

	MSU	NU	UW
1. Questionnaire to be posted	Oct. 28	Oct. 24	Nov. 8
2. Student deadline for posting return of questionnaire	Nov. 3	Oct. 29	Nov. 18
3. Begin follow-up phone calls to subjects not returning questionnaires *	Nov. 6	Nov. 2	Nov. 22
4. Begin phone calls to subjects to set appointments *	Nov. 8	Nov. 3	Nov. 18
5. Interviews	Nov. 9-30	Nov. 17-20	Dec. 1-4 Dec. 12-15

* Phone calls placed by the three project research assistants at the respective universities.

APPENDIX E

TABLES 1-28

Table 1 A summary of the participation of persisters (P) and non-persisters (NP) in the questionnaire and interview phases of the study

University	N	Questionnaires			Interviews		
		NP	P	Totals	NP	P	Totals
Michigan State University	144	39	55	94	30	47	77
Northwestern University	70	15	21	36	10	15	25
University of Wisconsin	112	41	50	91	32	42	74
Totals	326	95	126	221	72	104	176
Pretest group	124	39	44	83	14	18	32

* Total N's are reported for each institution. These totals each include an equal number of persisters and non-persisters.

Table 2 A comparison of the ages of persisters (P) and non-persisters (NP)

	NP	P
18 - 19	1 1.05	7 5.56
20	65 68.42	74 58.73
21	26 27.37	42 33.33
22 - 26	3 3.16	3 2.38
Total respondents	95	126
	$X^2 = 4.589$	
	df = 3	

* Significant at .05 level.

Note: In each cell, percentages are shown below corresponding frequencies.

Table 3 A comparison of the marital status of persisters (P) and non-persisters (NP)

	NP	P
Single	89 94.68	117 92.86
Married	5 5.32	9 7.14
No response	1 1.1	- -
Total respondents	95	126
	$X^2 = 0.300$	
	df = 1	

* Significant at .05 level.
- Represents zero frequency.

Note: 1. In each cell, percentages are shown below corresponding frequencies.
2. In chi-square tables, percentages in the "No response" category are based on the number of total respondents to the questionnaire.

Table 4 A comparison of persisters (P) and non-persisters (NP) with respect to the sizes of their home towns and communities in which their high schools were located

	Home town		High school community	
	NP	P	NP	P
200,000 and over	11 11.58	14 11.11	12 12.63	10 7.94
100,000 to 199,999	10 10.53	14 11.11	9 9.47	14 11.11
50,000 to 99,999	14 14.74	6 4.76	14 14.74	6 4.76
25,000 to 49,999	14 14.74	23 18.25	12 12.63	23 18.25
10,000 to 24,999	16 16.84	18 14.29	20 21.05	21 16.67
2,500 to 9,999	14 14.74	26 20.63	12 12.63	28 22.22
Under 2,500	16 16.84	25 19.84	16 16.84	24 19.05
Total respondents	95	126	95	126
	$X^2 = 7.916$		$X^2 = 11.835$	
	df = 6		df = 6	

* Significant at .05 level.

Note: In each cell, percentages are shown below corresponding frequencies.

Table 5 A comparison of persisters (P) and non-persisters (NP) with respect to the urban-rural characteristics of their home towns and communities in which their high schools were located

	Home town		High school community	
	NP	P	NP	P
Central city	29 30.53	28 22.22	29 30.53	23 18.25
Suburban community	41 43.16	75 59.52	41 43.16	78 61.90
Non-suburban community	25 26.32	23 18.25	25 26.32	25 19.84
Total respondents	95	126	95	126
	$X^2 = 5.833$		$X^2 = 8.006$*	
	df = 2		df = 2	

* Significant at .05 level.

Note: In each cell, percentages are shown below corresponding frequencies.

Table 6 A comparison of persisters (P) and non-persisters (NP) with respect to the sizes of their high school graduating classes

	NP	P
1 - 99	17 17.89	30 23.81
100 - 249	27 28.42	43 34.13
250 - 499	34 35.79	38 30.16
500 - 749	17 17.89	13 10.32
750 or more	- -	2 1.59
Total respondents	95	126
	$X^2 = 5.774$	
	df = 4	

* Significant at .05 level.
- Represents zero frequency.

Note: In each cell, percentages are shown below corresponding frequencies.

Table 7 A comparison of the number of siblings of persisters (P) and non-persisters (NP)

	Brothers		Sisters	
	NP	P	NP	P
None	33 34.74	44 34.92	39 41.05	47 37.30
One	32 33.68	50 39.68	44 46.32	44 34.92
Two	23 24.21	19 15.08	6 6.32	16 12.70
Three	3 3.16	8 6.35	4 4.21	11 8.73
Four	2 2.11	3 2.38	1 1.05	4 3.17
Five - seven	2 2.11	2 1.59	1 1.05	4 3.17
Total respondents	95	126	95	126
	$X^2 = 4.109$		$X^2 = 7.965$	
	df = 5		df = 5	

* Significant at .05 level.

Note: In each cell, percentages are shown below corresponding frequencies.

Table 8 A comparison of the number of older and younger siblings of persisters (P) and non-persisters (NP)

	Older brothers		Younger brothers		Older sisters		Younger sisters	
	NP	P	NP	P	NP	P	NP	P
None	65 68.42	76 60.32	53 55.79	78 61.90	70 73.68	77 61.11	60 63.16	76 60.32
One	22 23.16	40 31.75	25 26.32	36 28.57	22 23.16	32 25.40	26 27.37	35 27.78
Two	7 7.37	6 4.76	13 13.68	7 5.56	3 3.16	11 8.73	6 6.32	11 8.73
Three - six	1 1.05	4 3.17	4 4.21	5 3.97	- -	6 4.76	3 3.16	4 3.17
Total respondents	95	126	95	126	95	126	95	126
	$X^2 = 3.685$		$X^2 = 4.404$		$X^2 = 8.577$		$X^2 = 0.485$	
	df = 3		df = 3		df = 3		df = 3	

* Significant at .05 level.
- Represents zero frequency.

Note: In each cell, percentages are shown below corresponding frequencies.

Table 9 A comparison of the birth order of persisters (P) and non-persisters (NP)

	NP	P
No other children	9 9.47	10 7.94
Oldest child	42 44.21	38 30.16
A middle child	19 20.00	35 27.78
Youngest child	24 25.26	41 32.54
One of twins, etc.	1 1.05	2 1.59
Total respondents	95	126
	$X^2 = 5.533$	
	df = 4	

* Significant at .05 level.

Note: In each cell, percentages are shown below corresponding frequencies.

Table 10 A comparison of persisters (P) and non-persisters (NP) with respect to the formal educations of their fathers and mothers

	Father		Mother	
	NP	P	NP	P
Some elementary school	4 4.21	1 0.80	- -	- -
Elementary graduate	8 8.42	14 11.20	8 8.42	11 8.73
Some high school	6 6.32	14 11.20	7 7.37	8 6.35
High school graduate	37 38.95	24 19.20	42 44.21	39 30.95
Some college	12 12.63	23 18.40	19 20.00	37 29.37
College graduate	17 17.89	35 28.00	17 17.89	27 21.43
Master's degree	6 6.32	7 5.60	2 2.11	4 3.17
Doctorate or professional degree	5 5.26	7 5.60	- -	- -
No response	- -	1 0.8	- -	- -
Total respondents	95	126	95	126
	$X^2 = 15.706$		$X^2 = 5.129$	
	df = 7		df = 5	

* Significant at .05 level.
- Represents zero frequency.

Note: 1. In each cell, percentages are shown below corresponding frequencies.
2. In chi-square tables, percentages in the "No response" category are based on the number of total respondents to the questionnaire.

Table 11 A comparison of persisters (P) and non-persisters (NP) with respect to the prestige ratings of their fathers' present occupations (FPO), fathers' occupations at respondents' births (FRB), and mothers' present occupations (MPO)

	FPO		FRB		MPO	
	NP	P	NP	P	NP	P
40 - 44	- -	- -	1 1.43	1 1.09	- -	- -
45 - 49	- -	- -	- -	- -	- -	- -
50 - 54	4 4.44	15 12.93	6 8.57	19 20.65	2 6.45	3 7.14
55 - 59	3 3.33	4 3.45	2 2.86	7 7.61	- -	3 7.14
60 - 64	1 1.11	3 2.59	2 2.86	5 5.43	- -	1 2.38
65 - 69	19 21.11	16 13.79	14 20.00	14 15.22	7 22.58	8 19.05
70 - 74	27 30.00	20 17.24	23 32.86	13 14.13	15 48.39	16 38.10
75 - 79	17 18.89	16 13.79	10 14.29	8 8.70	6 19.35	11 26.19
80 - 84	17 18.89	31 26.72	10 14.29	17 18.48	1 3.23	- -
85 - 89	2 2.22	11 9.48	2 2.86	8 8.70	- -	- -
No response	5 5.3	10 7.9	25 26.3	34 27.0	64 67.4	84 66.7
Total respondents	95	126	95	126	95	126
	$X^2 = 16.131$*		$X^2 = 16.556$		$X^2 = 5.231$	
	df = 7		df = 8		df = 6	

* Significant at .05 level.
- Represents zero frequency.

Note: 1. In each cell, percentages are shown below corresponding frequencies.
2. In chi-square tables, percentages in the "No response" category are based on the number of total respondents to the questionnaire.

Table 12 A comparison of the perceived socioeconomic status of the families of persisters (P) and non-persisters (NP)

	NP	P
Upper class	6 6.32	2 1.63
Middle class	76 80.00	90 73.17
Working class or lower class	13 13.68	31 25.20
No response	- -	3 2.4
Total respondents	95	126
	$X^2 = 7.065$	
	df = 2	

* Significant at .05 level.
- Represents zero frequency.

Note: 1. In each cell, percentages are shown below corresponding frequencies.
2. In chi-square tables, percentages in the "No response" category are based on the number of total respondents to the questionnaire.

Table 13 A comparison of persisters (P) and non-persisters (NP) with respect to their parents' attitudes toward college attendance during respondents' high school years

	NP	P
It was expected that all the children would go to college.	49 51.58	57 45.60
Parents encouraged those children who wanted to go to college to do so, but it was not assumed that all would go.	41 43.16	60 48.00
Either it was not assumed that all the children would go to college or the parents discouraged college attendance.	5 5.26	8 6.40
No response	- -	1 0.8
Total respondents	95	126
	$X^2 = 0.794$	
	df = 2	

* Significant at .05 level.
- Represents zero frequency.

Note: 1. In each cell, percentages are shown below corresponding frequencies.
2. In chi-square tables, percentages in the "No response" category are based on the number of total respondents to the questionnaire.

Table 14 A comparison of persisters (P) and non-persisters (NP) with respect to their parents' attitudes toward college attendance for their sons and daughters

	NP	P
It was assumed that the boys, but not necessarily the girls, would go to college.	8 8.70	8 7.14
It was assumed that the girls, but not necessarily the boys, would go to college.	- -	- -
It was assumed that children who wanted to go to college should be encouraged to do so.	46 50.00	62 55.36
It was assumed that any of the children who wanted to go to college would have to make it without the encouragement of his parents.	4 4.35	5 4.46
It was assumed that all children would go to college.	34 36.96	37 33.04
No response	3 3.2	14 11.1
Total respondents	95	126
	$X^2 = 0.654$	
	df = 3	

* Significant at .05 level.
- Represents zero frequency.

Note:
1. In each cell, percentages are shown below corresponding frequencies.
2. In chi-square tables, percentages in the "No response" category are based on the number of total respondents to the questionnaire.

Table 15 A comparison of persisters (P) and non-persisters (NP) with respect to their assessments of their families' sacrifices made to permit college attendance

	NP	P
No sacrifice	12 12.63	15 11.90
Small sacrifice	39 41.05	36 28.57
Moderate sacrifice	38 40.00	65 51.59
Great sacrifice or very great sacrifice	6 6.32	10 7.94
Total respondents	95	126
	$X^2 = 4.267$	
	df = 3	

* Significant at .05 level.

Note: In each cell, percentages are shown below corresponding frequencies.

Table 16 A comparison of persisters (P) and non-persisters (NP) with respect to their rankings of each of twelve selected reasons for coming to college

	To get a liberal education		To prepare for a vocation		For the prestige of a college degree		To be with old school friends		To make friends and helpful connections		For social enjoyment; "College Life"		To please parents or friends		Family tradition		To learn more of certain subjects		It was the thing to do, foregone conclusion; never questioned why		Without college training, there is less chance of getting a job		Will enable me to make more money	
	NP	P	NP	P	NP	P	NP	P	NP	P	NP	P	NP	P	NP	P	NP	P	NP	P	NP	P	NP	P
First	16 30.19	11 18.33	36 45.00	73 62.39	1 1.1	- -	- -	- -	- -	- -	- -	- -	1 3.23	- -	- -	- -	10 19.23	11 12.94	9 21.43	4 14.81	8 14.04	13 15.85	13 17.57	8 7.92
Second	17 32.08	13 21.67	19 23.75	18 15.38	1 1.1	3 2.4	- -	- -	2 2.1	1 0.8	2 2.1	- -	3 9.68	3 11.11	- -	- -	8 15.38	31 36.47	5 11.90	5 18.52	15 26.32	17 20.73	19 25.68	30 29.70
Third	8 15.09	9 15.00	9 11.25	14 11.97	6 6.3	3 2.4	- -	- -	3 3.2	4 3.2	2 2.1	7 5.6	3 9.68	3 11.11	- -	3 2.4	15 28.85	17 20.00	4 9.52	7 25.93	16 28.07	29 35.37	24 32.43	24 23.76
Fourth	7 13.21	13 21.67	11 13.75	7 5.98	12 12.6	9 7.1	- -	- -	7 7.4	12 9.5	4 4.2	4 3.2	9 29.03	8 29.63	2 2.1	2 1.6	7 13.46	15 17.65	11 26.19	6 22.22	10 17.54	19 23.17	9 12.16	23 22.77
Fifth	5 9.43	14 23.33	5 6.25	5 4.27	6 6.3	13 10.3	- -	2 1.6	1 1.1	14 11.1	11 11.6	16 12.7	15 48.39	13 48.15	2 2.1	3 2.4	12 23.08	11 12.94	13 30.95	5 18.52	8 14.04	4 4.88	9 12.16	16 15.84
No response	42 44.2	66 52.4	15 15.8	9 7.1	69 72.6	98 77.8	95 100.0	124 98.4	82 86.3	95 75.4	76 80.0	99 78.6	64 67.4	99 78.6	91 95.8	118 93.7	43 45.3	41 32.5	53 55.8	99 78.6	38 40.0	44 34.9	21 22.1	25 19.8
Total respondents	95	126	95	126	95	126	95	126	95	126	95	126	95	126	95	126	95	126	95	126	95	126	95	126
	$X^2 = 7.175$		$X^2 = 7.892$										$X^2 = 0.930$				$X^2 = 9.279$		$X^2 = 4.730$		$X^2 = 4.858$		$X^2 = 7.764$	
	df = 4		df = 4										df = 4				df = 4		df = 4		df = 4		df = 4	

* Significant at .05 level.
- Represents zero frequency.

Note: 1. In each cell, percentages are shown below corresponding frequencies.
2. In chi-square tables, percentages in the "No response" category are based on the number of total respondents to the questionnaire.

Table 17 A comparison of persisters (P) and non-persisters (NP) with respect to their ratings of ten characteristics of the "ideal" job and of their realistic job expectations

	Provide me an opportunity to use my special abilities or aptitudes		Provide me with a chance to earn a good deal of money		Permit me to be creative and original		Give me social status and prestige		Give me an opportunity to work with people rather than things		Enable me to look forward to a stable, secure future		Leave me relatively free of supervision by others		Give me a chance to exercise leadership		Provide me with adventure		Give me an opportunity to be helpful to others	
Characteristics of an ideal job	NP	P	NP	P	NP	P	NP	P	NP	P	NP	P	NP	P	NP	P	NP	P	NP	P
Very great importance	42 44.21	70 55.56	20 21.74	14 11.20	29 30.53	38 30.16	8 8.60	4 3.20	22 23.40	16 13.01	41 43.62	40 31.75	21 22.58	16 12.70	15 15.96	21 16.80	14 14.89	22 17.74	18 19.35	26 20.80
Great importance	40 42.11	37 29.37	36 39.13	64 51.20	34 35.79	47 37.30	31 33.33	26 20.80	34 36.17	32 26.02	29 30.85	57 45.24	29 31.18	38 30.16	42 44.68	47 37.60	26 27.66	32 25.81	34 36.56	45 36.00
Moderate importance	13 13.68	16 12.70	32 34.78	43 34.40	26 27.37	37 29.37	41 44.09	64 51.20	23 24.47	45 36.59	20 21.28	25 19.84	34 36.56	51 40.48	28 29.79	46 36.80	37 39.36	46 37.10	35 37.63	43 34.40
Little importance	- -	3 2.38	4 4.35	4 3.20	6 6.32	4 3.17	13 13.98	31 24.80	15 15.96	30 24.39	4 4.26	4 3.17	9 9.68	21 16.37	9 9.57	11 8.80	17 18.09	24 19.35	6 6.45	11 8.80
No response	- -	- -	3 3.2	1 0.8	- -	- -	2 2.1	1 0.8	1 1.1	3 2.4	1 1.1	- -	2 2.1	- -	1 1.1	1 0.8	1 1.1	2 1.6	2 2.1	1 0.8
Total respondents	95	126	95	126	95	126	95	126	95	126	95	126	95	126	95	126	95	126	95	126
	$X^2 = 6.201$		$X^2 = 5.624$		$X^2 = 1.293$		$X^2 = 9.685$*		$X^2 = 9.418$*		$X^2 = 5.138$		$X^2 = 5.231$		$X^2 = 1.501$		$X^2 = 0.450$		$X^2 = 0.593$	
Likelihood of finding characteristics	NP	P	NP	P	NP	P	NP	P	NP	P	NP	P	NP	P	NP	P	NP	P	NP	P
Very great likelihood	28 29.79	37 29.37	11 11.70	20 15.87	17 18.09	13 10.40	6 6.45	6 4.80	26 27.66	12 9.60	19 20.21	34 26.98	6 6.38	3 2.40	8 8.51	9 7.26	6 6.38	3 2.42	17 18.28	13 10.40
Great likelihood	52 55.32	63 50.00	43 45.74	68 53.97	31 32.98	39 31.20	39 41.94	42 33.60	37 39.36	42 33.60	50 53.19	68 53.97	19 20.21	23 18.40	37 39.36	42 33.87	19 20.21	28 22.58	29 31.18	47 37.60
Moderate likelihood	14 14.89	25 19.84	31 32.98	35 27.78	34 36.17	64 51.20	42 45.16	71 56.80	23 24.47	60 48.00	23 24.47	22 17.46	52 55.32	73 58.40	40 42.55	60 48.39	37 39.36	53 42.74	40 43.01	52 41.60
Little likelihood	- -	1 0.79	9 9.57	3 2.38	12 12.77	9 7.20	6 6.45	6 4.80	8 8.51	11 8.80	2 2.13	2 1.59	17 18.09	26 20.80	9 9.57	13 10.48	32 34.04	40 32.26	7 7.53	13 10.40
No response	1 1.1	- -	1 1.1	- -	1 1.1	1 0.8	2 2.1	1 0.8	1 1.1	1 0.8	1 1.1	- -	1 1.1	1 0.8	1 1.1	2 1.6	1 1.1	2 1.6	2 2.1	1 0.8
Total respondents	95	126	95	126	95	126	95	126	95	126	95	126	95	126	95	126	95	126	95	126
	$X^2 = 1.784$		$X^2 = 6.979$		$X^2 = 6.808$		$X^2 = 2.919$		$X^2 = 18.423$*		$X^2 = 2.410$		$X^2 = 2.454$		$X^2 = 0.993$		$X^2 = 2.373$		$X^2 = 3.541$	

* Significant at .05 level.
- Represents zero frequency.

Note: 1. In each cell, percentages are shown below corresponding frequencies.
2. In chi-square tables, percentages in the "No response" category are based on the number of total respondents to the questionnaire.

Table 18 A comparison of persisters (P) and non-persisters (NP) with respect to their assessments of their future incomes as compared to the incomes of their families

	NP	P
Higher income	64 68.09	92 73.60
About the same income	25 26.60	31 24.80
Lower income	5 5.32	2 1.60
No response	1 1.1	1 0.8
Total respondents	95	126
	X^2 = 2.619	
	df = 2	

* Significant at .05 level.

Note: 1. In each cell, percentages are shown below corresponding frequencies.
2. In chi-square tables, percentages in the "No response" category are based on the number of total respondents to the questionnaire.

Table 19 A comparison of expectations of annual earnings ten years after completion of formal education of persisters (P) and non-persisters (NP)

	NP	P
$4,999 or less	- -	- -
$5,000 - $9,999	12 12.77	16 12.90
$10,000 - $14,000	56 59.57	80 64.52
$15,000 - $19,999	19 20.21	25 20.16
$20,000 or over.	7 7.45	3 2.42
No response	1 1.1	2 1.6
Total respondents	95	126
	X^2 = 3.156	
	df = 3	

* Significant at .05 level.
- Represents zero frequency.

Note: 1. In each cell, percentages are shown below corresponding frequencies.
2. In chi-square tables, percentages in the "No response" category are based on the number of total respondents to the questionnaire.

Table 20 A comparison of high school extra-curricular activities of persisters (P) and non-persisters (NP)

	NP	P	X^2	df
Individual sports	43 45.26	55 43.65	0.057	1
Team sports	58 61.05	81 64.29	0.243	1
Science clubs	34 35.79	47 37.30	0.053	1
JETS club	2 2.11	6 4.76	1.096	1
Musical organizations	33 34.74	50 39.68	0.565	1
Dramatics	20 21.05	24 19.05	0.137	1
Publications (newspaper, year-book, etc.)	29 30.53	31 24.60	0.961	1
Speech and/or debate team	16 16.84	19 15.08	0.126	1
Foreign language clubs	26 27.37	27 21.43	1.048	1
Student government	46 48.42	47 37.30	2.748	1
Other	31 32.6	44 34.9		
Total respondents	95	126		

* Significant at .05 level.

Note: In each cell, percentages are shown below corresponding frequencies.

Table 21 A comparison of persisters (P) and non-persisters (NP) with respect to the ages when they first considered the possibility of a career in science or engineering

	NP	P
Ages 2 - 9	2 2.27	5 3.97
Age 10	6 6.82	13 10.32
Age 11	3 3.41	1 0.79
Age 12	10 11.36	26 20.63
Age 13	7 7.95	18 14.29
Age 14	13 14.77	23 18.25
Age 15	17 19.32	14 11.11
Age 16	18 20.45	13 10.32
Age 17	10 11.36	11 8.73
Ages 18 - 20	2 2.27	2 1.59
No response	7 7.4	- -
Total respondents	95	126
	$X^2 = 14.446$	
	df = 9	

* Significant at .05 level.
- Represents zero frequency.

Note:
1. In each cell, percentages are shown below corresponding frequencies.
2. In chi-square tables, percentages in the "No response" category are based on the number of total respondents to the questionnaire.

Table 22 A comparison of persisters (P) and non-persisters (NP) with respect to the ages when they decided to enroll in engineering schools

	NP	P
Ages 12 - 13	- -	3 2.38
Age 14	4 4.21	4 3.17
Age 15	3 3.16	12 9.52
Age 16	14 14.74	29 23.02
Age 17	52 54.74	45 35.71
Age 18	20 21.05	28 22.22
Ages 19 - 23	2 2.11	5 3.97
Total respondents	95	126
	$X^2 = 12.657$	
	df = 6	

* Significant at .05 level.
- Represents zero frequency.

Note: In each cell, percentages are shown below corresponding frequencies.

Table 23 A comparison of persisters (P) and non-persisters (NP) with respect to the incidence of personal contacts with people in the field of engineering prior to their entering college

	NP	P
Yes	51 54.26	71 58.20
No	43 45.74	51 41.80
No response	1 1.1	4 3.2
Total respondents	95	126
	$X^2 = 0.336$	
	df = 1	

* Significant at .05 level.

Note: 1. In each cell, percentages are shown below corresponding frequencies.

2. In chi-square tables, percentages in the "No response" category are based on the number of total respondents to the questionnaire.

Table 24 A comparison of majors upon matriculation of persisters (P) and non-persisters (NP)

	NP	P
General Engineering	14 14.74	14 11.11
Chemical Engineering	21 22.11	24 19.05
Civil Engineering	13 13.68	13 10.32
Electrical Engineering	27 28.42	42 33.33
Mechanical Engineering	15 15.79	22 17.46
Other Engineering	5 5.26	11 8.73
Total respondents	95	126
	$X^2 = 2.741$	
	df = 5	

* Significant at .05 level.

Note: In each cell, percentages are shown below corresponding frequencies.

Table 25 A comparison of prestige ratings of original engineering majors of persisters (P) and non-persisters (NP)

	NP	P
Eight-three	54 56.8	80 63.5
Eighty-four	2 2.1	- -
Eighty-five	17 17.9	23 18.3
Eighty-seven	22 23.2	23 18.3
Total respondents	95	126

- Represents zero frequency.

Note: In each cell, percentages are shown below corresponding frequencies.

Table 26 A summary of present departments or majors of non-persisters (NP)

	NP
Packaging	6 6.3
Other Agriculture	3 3.2
Arts and Letters	5 5.3
Economics	7 7.4
Other Business	26 27.4
Communication Arts	2 2.1
Education	1 1.1
Mathematics	7 7.4
Physics	- -
Chemistry	6 6.3
Other Natural Science	8 8.4
Psychology	7 7.4
Other Social Science	9 9.5
Other	4 4.2
No response	4 4.2
Total respondents	95

- Represents zero frequency.

Note: In each cell, percentages are shown below corresponding frequencies.

Table 27 A comparison of persisters (P) and non-persisters (NP) with respect to their sources of financial assistance during freshman and sophomore years in college

	NP	P	X^2	df
Parents	85 89.47	105 83.33	1.693	1
Relatives	6 6.32	7 5.56	0.057	1
Scholarship	57 60.00	65 51.59	1.550	1
Your savings	42 44.21	91 72.22	17.735*	1
Your part-time job	35 36.84	44 34.92	0.087	1
Your summer job	70 73.68	107 84.92	4.289	1
Loan	12 12.63	19 15.08	0.269	1
Other	2 2.1	5 4.0		
Total respondents	95	126		

* Significant at .05 level.

Note: In each cell, percentages are shown below corresponding frequencies.

Table 28 A comparison of persisters (P) and non-persisters (NP) with respect to the incidence of change in their long-range educational goals

	NP	P
Yes	76 80.0	73 57.9
No	14 14.7	48 38.1
No response	5 5.3	5 4.0
Total respondents	95	126

Note: In each cell, percentages are shown below corresponding frequencies.